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# ASSESSMENT OF DROUGHT AND WATER AVAILABILITY FOR CROP PRODUCTION IN THE RIO GRANDE BASIN

As requested by Conference Report 107-275

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Office of the Chief Economist**

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# **ASSESSMENT OF DROUGHT AND WATER AVAILABILITY FOR CROP PRODUCTION IN THE RIO GRANDE BASIN**

*As requested by Conference Report 107-275*

## **EXECUTIVE SUMMARY**

In the Conference Report, which accompanied Public Law 107-76, the Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act 2002, conferees raised concerns with respect to continuing severe drought along the United States/Mexico border in the areas of the Rio Grande Basin and Mexico's continuing failure to meet its water obligations to the area as delineated in the 1944 Water Treaty. Conference Report 107-275 requested that the Secretary of Agriculture provide a report to the Committees on Appropriations of the House and Senate by March 1, 2002, detailing the value of the annual loss of U.S. agricultural production resulting from this deficit and the Department's authorities and plans to assist agricultural interests in the Rio Grande watershed with the financial ramifications of Mexico's water debt. H.R. Conf. Rep. 107-275, at 48-49 (2001).

### **Water Supply and Use in the Rio Grande Basin**

This report covers the Texas counties of Cameron, Hidalgo, Starr, and Willacy that lie in the lower Rio Grande Basin. The Rio Grande Basin is highly dependent on surface water to supply its water needs. Based on 1995 data (the most recent available), surface water accounted for 98 percent of all water withdrawals. Irrigation accounted for 92 percent of surface withdrawals and 93 percent of total consumptive use.

The 1944 Water Treaty between the U.S. and Mexico contains provisions whereby Mexico is required to provide the United States with a minimum of 350,000 acre-feet of water per year, averaged in five-year cycles. At the conclusion of the five-year cycle ending on October 2, 1997, Mexico owed the United States about 1.025 million acre-feet of water. By early 2002, although Mexico had transferred some water from the international reservoirs since February 2000, Mexico's accumulated water debt from both the 1992-97 cycle and the 1997-2002 cycle had grown to approximately 1.5 million acre-feet.

An extended drought since 1993 on both the U.S. and Mexican sides of the Rio Grande has combined with the reduced Mexican inflows to diminish available water supplies in the main reservoirs, the Amistad and Falcon. Rio Grande water users are concerned about Mexico's ability to reduce these deficits, which have a direct impact on water availability in the region. For example, according to the Rio Grande Watermaster, irrigable land in 2002 for both Cameron and Hidalgo counties likely will be reduced by approximately 103,000 acres, a drop of 29 percent from 1992, due in part to water shortages.

### **Crop Production in the Rio Grande Basin**

Conference Report 107-275 requests the United States Department of Agriculture (USDA) estimate the value of the annual loss of U.S. agricultural production due to the deficit in Mexican water deliveries. USDA is unable to quantify such losses for several reasons. First, the water deficit in Mexican deliveries could not be related to the annual surface water withdrawals by agricultural irrigators due to lack of data. Second, data on acreage planted to all crops, irrigated and dryland, is incomplete. Third, there are



# ASSESSMENT OF BROUGHT AND WATER AVAILABILITY FOR CROP PRODUCTION IN THE RIO GRANDE BASIN

As requested by Congress, Report 107-216

## EXECUTIVE SUMMARY

In the Committee Report which accompanied Public Law 107-216, the Agriculture, Rural Development, Food and Drug Administration, and Natural Resources Appropriations and Related Matters Committee stated that the United States-Mexico border is the area in the Rio Grande Basin and Mexico's economy depend to most in water availability to the area as defined in the 1944 Water Treaty. Committee Report 107-216 requested that the Secretary of Agriculture provide a report to the Committee on Appropriations of the House and Senate by March 1, 2002, on the value of the annual flow of 1.5 billion gallons of water reaching from this border and the Government's contribution and plans to make agricultural water available to the Rio Grande, consistent with the treaty provisions in Article 17 of the 1944 Water Treaty (107-216, at 48-49 (2001)).

## Water Supply and Use in the Rio Grande Basin

This report assesses the water resources of Colorado, New Mexico, and Arizona and the Rio Grande Basin. The Rio Grande Basin is highly dependent on surface water to supply its water needs. Based on 1997 data, the basin's water resources are estimated to account for 95 percent of all water withdrawals. Irrigation accounted for 93 percent of surface withdrawals and 85 percent of total withdrawals.

The 1944 Water Treaty between the U.S. and Mexico contains provisions whereby Mexico is required to provide the United States with a minimum of 1,500,000 acre-feet of water per year, averaged in five-year cycles. At the completion of the five-year cycle ending on October 1, 1997, Mexico owed the United States about 1,015 million acre-feet of water. By early 2002, although Mexico had transferred some water from the international river to Mexico, Mexico's accumulated water debt from both the 1997-2002 cycle and the 1997-2002 cycle had grown to approximately 1.5 billion acre-feet.

An extended drought since 1997 in both the U.S. and Mexican sides of the Rio Grande has resulted in the reduced Mexican inflows to Arizona, New Mexico, and Texas. The reduced water inflows have caused a significant reduction in the water available for agriculture and other uses in the region. For example, according to the Rio Grande Water Compact, a direct impact on water availability in the region. For example, according to the Rio Grande Water Compact, a direct impact on water availability in the region. For example, according to the Rio Grande Water Compact, a direct impact on water availability in the region. For example, according to the Rio Grande Water Compact, a direct impact on water availability in the region.

## Crop Production in the Rio Grande Basin

Committee Report 107-216 requested the United States Department of Agriculture (USDA) assess the value of the annual flow of 1.5 billion gallons of water to the border in Mexico in water deliveries. USDA is unable to quantify such flows for several reasons. First, the water deficit in the Rio Grande Basin could not be related to the water deficit in agricultural regions due to lack of data. Second, data on average planted to all crops irrigated and irrigated is unavailable. Third, there are



numerous confounding factors that have affected planted area in the region during the period of deficit deliveries. These factors include insect losses; devastating freezes affecting citrus; low crop prices, particularly following the runup in major crop prices in the mid - 1990's; rising farm production costs, especially in the mid - 1990's and in 2000 and 2001 due to high energy costs; economic development and competing uses for land; competition from horticultural imports from Mexico and other countries; and concerns over pesticide use and regulations. Reductions in production of one crop may also be offset by producers shifting to other crops. USDA does not have county-level econometric models that are able to decompose all of these factors into their individual contributions to changes in the value of crop production in the Rio Grande Basin.

An assessment of the available data suggests that insufficient water likely played an important role in cropping choices of Rio Grande Basin producers. Although definitive conclusions are not possible given the data limitations and the many confounding factors, several indicators suggest water delivery deficits may have had their most pronounced effect during the late 1990's. During this period, the data reviewed indicate that, except for 1997, annual average precipitation was well below normal; water inflows to the Rio Grande above the Amistad and Falcon reservoirs were unusually low, especially on the Mexican side; water storage levels in the Amistad and Falcon reservoirs hit the lowest levels in three decades beginning in 1995 and continuing through the current period; and water application rates as measured in acre-feet of irrigation water applied per acre fell to levels well below the average of the first half of the 1990's.

Coinciding with these atypical meteorological and hydrological events, the cumulative deficit of Mexican water deliveries rose from 0.5 million acre-feet at the end of 1995 to 1.4 million acre-feet by the end of 1999. Harvested acreage of field crops for which data are available (cotton, sorghum, corn and sugarcane) in the Rio Grande Basin fell sharply during the 1996-99 period, compared with earlier periods, but then began to rise toward earlier levels in 2000. Therefore, focusing on the 1996-1999 period, total harvested acreage of field crops in the Rio Grande Basin averaged 616,000 acres, down 15 percent from the 728,000 acres averaged during 1990-95. Irrigated acreage in the Rio Grande Basin fell 17 percent to 208,000 from 251,000. Based on the Texas state season-average farm prices for the field crops during 1996-99, the annual average value of the decline in production of field crops during 1996-99 compared with 1990-95 was \$34 million. Lack of data prevents development of loss estimates for other crops.

### **USDA Authorities and Assistance to the Rio Grande Valley**

USDA has a broad range of authorities vested in different agencies that are used to respond to natural disasters, including drought. This response capability includes technical and financial assistance, consultation and analysis, technology transfers, and landscape restoration. These functions reside primarily in the Natural Resources Conservation Service (NRCS), the Risk Management Agency (RMA), and the Farm Service Agency (FSA).

USDA has been actively engaged in the Rio Grande Basin through its emergency and disaster programs, as well as with ongoing commodity support programs. USDA programs have contributed about \$100 million annually between 1999-2001 for the four Texas counties. Programs such as the Wetlands Reserve Program and the Conservation Reserve Program have combined to take over 100,000 acres of land out of production for environmental and conservation purposes.



numerous contributing factors that have affected planted area in the region during the period of drought deliveries. These factors include: (a) declining fertilizer prices affecting output; (b) crop losses, particularly following the onset of heavy crop losses in the mid-1990s; (c) heavy rain production losses, especially in the mid-1990s and in 2001 due to high energy costs; (d) economic development and competing uses for land; (e) increasing demand for agricultural inputs from Mexico and other countries; and (f) concerns over pesticide use and resistance. Reductions in production of one crop may also be offset by producers shifting to other crops. USDA does not have county-level econometric models that are able to decompose all of these factors into their individual contributions to changes in the value of crop production in the Rio Grande Basin.

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Consistent with these signals, unprecedented and hydrological events, the cumulative effect of which water deliveries rose from 6.7 million acre-feet at the end of 1995 to 1.4 million acre-feet by the end of 1999. Harvested acreage of field crops for which data are available (cotton, sorghum, corn and sugarcane) in the Rio Grande Basin fell sharply during the 1995-99 period, compared with earlier periods. For example, cotton acreage in the Rio Grande Basin averaged 61,000 acres, down 15 percent from the 1995-99 period, beginning on the 1995-1999 period. Sorghum, beginning on the 1995-1999 period, fell from 128,000 acres averaged during 1995-99 to 108,000 acres during 1995-99. Corn, beginning on the 1995-99 period, fell from 208,000 acres averaged during 1995-99 to 198,000 acres during 1995-99. Based on the 1995-99 season-average farm prices for the field crops during 1995-99, the annual average value of the decline in production of field crops during 1995-99 compared with 1990-95 was \$34 million. Lack of data prevents development of an estimate for other crops.

#### USDA Activities and Assistance to the Rio Grande Valley

USDA has a broad range of activities aimed at different agencies that are used to respond to natural disasters, including drought. This response capability includes technical and financial assistance, consultation and analysis, technology transfer, and disaster restoration. These functions reside primarily in the Natural Resources Conservation Service (NRCS), the Risk Management Agency (RMA), and the Farm Service Agency (FSA).

USDA has been actively engaged in efforts to assist the Rio Grande Basin through its emergency and disaster programs, as well as with ongoing conservation programs. USDA programs have contributed about \$100 million annually between 1995-2001 for the Rio Grande Basin. Programs such as the Wetlands Reserve Program and the Conservation Reserve Program have contributed to take over 100,000 acres of land out of production for environmental and conservation purposes.



USDA will continue to provide support to the region to assist in addressing both short-term water and weather emergencies. With regard to longer term efforts to address water availability and quality, there may be room for further collaboration between USDA and the United States Department of the Interior, Bureau of Reclamation. For example, in December 2000, the U.S. Congress approved and the President signed into law the Lower Rio Grande Valley Water Resources Conservation and Improvement Act of 2000, Pub. L. No. 106-576, which directs the Secretary of the Interior, through the Bureau of Reclamation, to conserve and enhance the water supplies of the Lower Rio Grande Valley. Under this legislation and current efforts such as the “Bridging the Headgate” partnership with NRCS, the National Association of Conservation Districts, the National Association of State Conservation Agencies, the Western States Water Council, and the National Water Resources Association, USDA may be able to further contribute to long-term solutions to water supply needs and conservation in the Rio Grande Basin.

USDA is committed to ensuring that the full range of existing loan, grant, payment and technical assistance programs it administers are available to eligible producers in the Rio Grande Basin. USDA will continue to ensure that these programs are timely administered and responsive to the needs of producers in the area. In addition, the Secretary of Agriculture and USDA staff would be pleased to work with members of Congress, producers and other interested parties regarding possible additional effective efforts to help mitigate the effects of drought and insufficient irrigation water supplies in the Rio Grande Basin.

The first part of the paper discusses the importance of the study and the objectives of the research. It also provides a brief overview of the literature review and the methodology used in the study. The second part of the paper presents the results of the study and discusses the implications of the findings. The third part of the paper concludes the study and provides some suggestions for future research.

The study was conducted using a quantitative research design. The data was collected from a sample of 100 participants. The results of the study show that there is a significant relationship between the variables studied. The findings have important implications for the field of study and provide a basis for further research.



# **ASSESSMENT OF DROUGHT AND WATER AVAILABILITY FOR CROP PRODUCTION IN THE RIO GRANDE BASIN**

*As requested by Conference Report 107-275*

## **Introduction and Scope**

In the Conference Report, which accompanied Public Law 107-76, the Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act 2002, conferees raised concerns with respect to continuing severe drought along the United States/Mexico border in the areas of the Rio Grande Basin and Mexico's continuing failure to meet its water obligations to the area as delineated in the 1944 Water Treaty. Conference Report 107-275 requested that the Secretary of Agriculture provide a report to the Committees on Appropriations of the House and Senate by March 1, 2002, detailing the value of the annual loss of U.S. agricultural production resulting from this deficit and the Department's authorities and plans to assist agricultural interests in the Rio Grande watershed with the financial ramifications of Mexico's water debt. H.R. Conf. Rep. 107-275, at 48-49 (2001).

This report responds to Conference Report 107-275. The report covers the Texas counties of Cameron, Hidalgo, Starr, and Willacy that lie in the lower Rio Grande Basin and is divided into three main sections. The first section of the report describes water supply and use in the region, including background information on the Rio Grande Reservoirs and the 1944 Water Treaty with Mexico. Information is presented on historical water use, current reservoir and rainfall levels, and water availability in the region. The second part of the report assesses recent trends in crop area, yield, and production in the four U.S. counties, as well as in the Rio Grande Basin in Mexico. The next section describes the Department's authorities and response to the impact of the ongoing drought and water shortages on U.S. agricultural interests in the lower Rio Grande Valley. The report concludes with some suggestions for possible future USDA activities to address the water problems in the region.

## **Water Supply and Use in the Rio Grande Basin**

The Rio Grande Basin is highly dependent on surface water to meet its water needs, and irrigation accounts for a high proportion of water use. The most recent complete data available on water use are from the U.S. Geological Survey's National Water Use Program for 1995 for the four Texas counties in the Rio Grande Basin. According to these data, surface water accounted for more than 98 percent of total water withdrawals for the four counties (Table 1). Total withdrawals were 1.6 million acre-feet in 1995; Hidalgo accounted for 1 million acre-feet. Irrigation accounted for 92 percent of surface water withdrawals and 93 percent of total consumptive use. Total consumptive use of water in 1995 was 1 million acre-feet, with Hidalgo accounting for 62 percent of total use. Surface water needs of 91 percent of the region's population. Water use for major crops has generally declined since the mid-1990's, with 1994 and 1995 being years of highest use in the 1990's (Table 2).

THE UNIVERSITY OF CHICAGO  
DEPARTMENT OF POLITICAL SCIENCE  
POLITICAL SCIENCE 301

LECTURE NOTES

The first part of the lecture dealt with the concept of the state. The state is defined as a political entity that has a monopoly on the use of force within a given territory. The state is also responsible for the provision of public goods and the maintenance of order. The lecture then discussed the different types of states, including unitary states, federal states, and confederations. It also examined the relationship between the state and society, and the role of the state in the economy.

The second part of the lecture focused on the concept of democracy. Democracy is defined as a system of government in which the people have the right to elect their representatives. The lecture then discussed the different types of democracies, including direct democracy, representative democracy, and semi-direct democracy. It also examined the challenges to democracy, such as corruption, inequality, and the rise of authoritarianism.

CONCLUSION

The lecture concluded by discussing the importance of political science in understanding the world. Political science is a discipline that seeks to understand the behavior of political actors and the functioning of political systems. It is a field that is constantly evolving, and it is important for students to stay up-to-date on the latest research and developments in the field.



**Table 1 – Freshwater Withdrawals and Consumptive Use in the Rio Grande Basin, 1995**

Item	Cameron	Hidalgo	Starr	Willacy	Total
	<i>thousand acre-feet per year</i>				
<b>Withdrawals <u>1/</u></b>	511.7	1,045.1	55.6	0.1	1,612.5
Surface	510.4	1,020.7	54.2	0.1	1,585.4
Ground	1.3	24.4	1.4	0.0	27.1
<b>Irrigation <u>2/</u></b>	455.6	956.1	45.4	0.0	1,457.1
Surface	455.6	941.2	45.1	0.0	1,441.9
Ground	0.0	14.9	0.3	0.0	15.2
<b>Other</b>	56.1	83.0	10.2	0.1	155.4
Surface	54.6	79.5	9.1	0.1	143.5
Ground	1.3	9.5	1.1	0.0	11.3
<b>Consumptive Use <u>3/</u></b>	307.8	621.3	37.8	41.8	1,008.6
<i>Irrigation</i>	285.2	585.1	32.4	39.4	942.1
<i>Other</i>	22.6	36.2	5.4	2.4	66.5
<b>Population Served <u>4/</u></b>	309.6	479.8	51.5	19.5	860.3
<i>Surface</i>	299.7	417.1	45.6	19.5	781.9
<i>Ground</i>	9.9	62.7	5.9	0.0	78.5

1/ Amount of water diverted from a surface-water source or extracted from a groundwater source. 2/ Includes applying water artificially to farm and horticultural crops. Some data include water to irrigate parks and golf courses. 3/ Amount of withdrawn water lost to immediate environment through evaporation, plant transpiration, incorporation in products or crops, or consumption by humans and livestock. 4/ Thousands.

Source: USDA/Economic Research Service based on U.S. Geologic Survey data.

### Rio Grande Reservoirs and the 1944 Water Treaty

The two main reservoirs that supply water to the lower Rio Grande Valley are the Falcon and Amistad International Reservoirs, completed in 1953 and 1968, respectively. These reservoirs are operated by the International Boundary and Water Commission (IBWC) for flood control and water supply purposes. Two treaties (1906 and 1944) between the United States and Mexico contain basic provisions regarding the development and use of Rio Grande waters by the two countries. The 1944 Treaty, administered by the IBWC, contains provisions whereby Mexico is required to provide the United States with a minimum of 350,000 acre-feet of water per year, averaged in five-year cycles, from six named Mexican tributaries (Rio Conchos, San Diego, San Rodrigo, Escondido, Salado, and the Las Vacas Arroyo). These tributaries are located below Fort Quitman, Texas (80 miles southeast of El Paso), and contribute directly to the Amistad-Falcon water supply. When tributary inflows from Mexico are reduced, water available to U.S. interests along the Rio Grande River is reduced.





**Table 2 – Acre-feet of Water Used, Selected Crops , Rio Grande Basin**

Year	Cotton	Sorghum	Citrus	Sugarcane	Vegetables	Forage, hay
1992	148,167	75,400	61,026	97,425	93,550	106,116
1993	167,350	69,317	42,625	167,880	275,625	138,467
1994	300,464	249,133	59,483	164,404	207,300	171,256
1995	307,492	121,605	60,317	137,400	228,376	148,923
1996	101,583	132,933	46,696	76,817	214,167	105,600
1997	72,917	86,042	39,789	57,425	173,967	92,053
1998	105,717	79,884	46,696	70,500	175,050	74,853
1999	80,050	45,633	43,780	68,700	174,975	56,571

Source: Texas Water Development Board, annual irrigation survey.

An extended drought since 1993 on both the U.S. and Mexican sides of the Rio Grande River has combined with the reduced inflows to diminish available water supplies in the Amistad and Falcon Reservoirs. In the five-year cycle ending on September 30, 1997, Mexico owed the United States about 1.025 million acre-feet of water (Table 3). By early 2002, although Mexico had transferred some water from the international reservoirs since February 2000, Mexico's accumulated water debt from both the 1992-97 cycle and the 1997-2002 cycle had grown to about 1.5 million acre-feet.

According to Article 4 of the 1944 Treaty, total flow from these Mexican tributaries can average less than 350,000 acre-feet per year over a five-year cycle without Mexico being in "violation" of the treaty if there is a situation of extraordinary drought. However, the treaty requires that Mexico make up this deficit by the end of the second five-year cycle. Extraordinary drought is not defined in the treaty. Rio Grande Basin water users are concerned about Mexico's ability to reduce these deficits, which have a direct impact on water availability in the region.

### Rio Grande Basin

The Rio Grande Basin extends southward from southern Colorado through New Mexico and Texas, to the Gulf of Mexico (Figure 1). Amistad Reservoir is used for the bulk storage of water, while the Falcon Reservoir is used to accept and release irrigation and municipal water as needed. The entire Rio Grande Basin (United States and Mexico) covers approximately 355,500 square miles. Most of the snowmelt in the headwaters area of the Rio Grande is used by New Mexico and Colorado. The principal tributaries of the Rio Grande in the United States are the Pecos and Devils Rivers. In Mexico, the Rio Conchos, Rio Salado, and the Rio San Juan are the largest tributaries of the Rio Grande. In Mexico, an extensive system of reservoirs has been constructed on the tributaries of the Rio Grande, most notably the Rio Conchos. Water stored in these reservoirs is used by Mexico for municipal, industrial, and irrigation purposes.

Table 1. Summary of the results of the regression analysis.

Variable	Parameter estimate	Standard error	t-value	Probability >  t
Intercept	1.234	0.012	102.8	<.001
Age	0.005	0.001	5.2	<.001
Gender	0.123	0.045	2.7	.008
Education	0.012	0.003	4.1	<.001
Income	0.008	0.002	3.8	<.001
Health status	0.015	0.004	3.5	<.001
Marital status	0.009	0.002	4.5	<.001
Religious beliefs	0.007	0.002	3.2	<.001
Life satisfaction	0.006	0.002	3.1	<.001
Depression	0.004	0.001	3.5	<.001
Stress	0.003	0.001	3.2	<.001
Loneliness	0.002	0.001	2.8	.006
Quality of life	0.001	0.001	2.5	.012

The results of the regression analysis are presented in Table 1. The model explains 78% of the variance in the dependent variable. The independent variables are Age, Gender, Education, Income, Health status, Marital status, Religious beliefs, Life satisfaction, Depression, Stress, Loneliness, and Quality of life. The parameter estimates, standard errors, t-values, and probabilities are shown for each variable.

The results show that all independent variables are significant predictors of the dependent variable. The parameter estimates indicate the direction and magnitude of the relationship between each variable and the dependent variable. For example, the parameter estimate for Age is 0.005, indicating a positive relationship between age and the dependent variable.

Discussion

The findings of this study suggest that a variety of factors, including demographic, psychological, and social factors, are associated with the dependent variable. The results support the hypothesis that these factors are related to the dependent variable. The findings have implications for the development of interventions to improve the dependent variable. For example, interventions that target the psychological and social factors identified in this study may be effective in improving the dependent variable.



**Table 3 – Mexico's Water Deficit 1992-2001 (October-September For Year Ending) 1/**

Cycle Year	Minimum Required Acre-Feet	Delivered Acre-Feet	Difference Between Delivered and Minimum Required Acre-Feet	Cumulative Deficit Acre-Feet
1992-93	350,000	296,542	(53,458)	(53,458)
1993-94	350,000	167,632	(182,368)	(235,826)
1994-95	350,000	75,283	(274,717)	(510,543)
1995-96	350,000	60,457	(289,543)	(800,086)
1996-97	350,000	124,812	(225,188)	(1,025,274)
<b>End of five-year cycle</b>				
1997-98	350,000	120,098	(229,902)	(1,255,176)
1998-99	350,000	165,579	(184,421)	(1,439,597)
1999-00	350,000	406,333	56,333	(1,383,264)
2000-01	350,000	427,568	41,242	(1,342,022)

1/ Data provided by the IBWC. An annual cycle runs from October 3 - October 2.

The lower Rio Grande Basin experiences hot, humid summers and relatively mild, dry winters. In July and August, maximum temperatures normally range from 96 to 98 degrees Fahrenheit, maintaining high evaporation rates. Annual rainfall varies across the lower Rio Grande region from an average of 28 inches at the coast to 19 inches in the northwestern portion of the region. Most precipitation occurs during the spring, from April through June, and during the late summer and early fall, from August through October. Annual evaporation greatly exceeds the annual rainfall, necessitating irrigation for crop production. Tropical storms and hurricanes can provide a large portion of the surface water runoff captured in the reservoirs within the Rio Grande Basin. Over the past decade, tropical activity has not made a significant contribution to the overall water supply of the region.

#### Drought and Reservoir Storage

In the last decade, a string of droughts has affected the Rio Grande Basin, resulting in near- to below-normal annual precipitation during 8 of the last 9 years (1993-2001) in the U.S. portion of the basin. The exception was in 1997, when wet weather in the spring and fall resulted in above-normal rainfall for the year. The drought since 1993 is the region's most serious since both international reservoirs on the Rio Grande were completed.





The severity of the extended drought in the Rio Grande Basin is evident from rainfall and streamflow data, as well as from the low storage levels in both Amistad and Falcon Reservoirs. In Figure 2, annual rainfall was averaged for climate divisions located within the entire U.S. portion of the Rio Grande Basin for the period of record 1900-2001. A normal annual rainfall value was then calculated over the entire period and departures of annual rainfall from normal were computed. Annual rainfall departures for the Rio Grande Basin show that the driest period on record occurred during the 1950's, when severe drought gripped the region. Although the Falcon Reservoir was completed during the region's historic drought of the 1950's, storage was temporarily boosted in late-June 1954 by the local inundation due to Hurricane Alice. An extended period of above-normal rainfall from the late 1960's through the early 1990's was followed by the prolonged period of below-normal rainfall beginning in 1993 and continuing through 2001.

The Mexican portion of the Rio Grande Basin has also experienced a prolonged period of below-normal rainfall, beginning in 1993. Annual rainfall data were averaged for three weather stations located in the Rio Conchos Basin in the Mexican state of Chihuahua for the time period 1948 to 2001. A normal annual rainfall value was then calculated over the time period and departures of annual rainfall were generated (Figure 3). Annual rainfall departures for the Rio Conchos Basin in Mexico reveal a similar pattern to those for the U.S. side of the Rio Grande Basin. Like on the U.S. side, the Rio Conchos Basin experienced a prolonged and severe drought during the 1950's, with several above-normal rainfall years in the 1980's. Since 1993, annual rainfall across the Rio Conchos Basin has averaged below-normal during 8 of the last 9 years, with 1994 being the driest. The below-normal rainfall pattern is similar in duration to that observed during the 1950's.

Historical annual U.S. and Mexican river inflows into the Rio Grande from watersheds above the Amistad and Falcon Reservoirs are shown in Figure 4. These data were obtained from the *Rio Grande Regional Water Plan* and are based on historical streamflow gage records and water balance calculations conducted by the IBWC. These data indicate that U.S. inflow into the Rio Grande has averaged about 1,790,000 acre-feet per year, while the total inflow from Mexico has averaged about 1,350,000 acre-feet per year. These numbers summarize inflows to the Rio Grande and should not be used to determine U.S. or Mexican contributions to the storage system under the 1944 Treaty.

The greatest inflows (1954 for the United States, and 1971 for both the United States and Mexico) for each of the two countries have approached 4 million acre-feet. The lowest inflows (1952 and 1956 for both countries) were near 700,000 acre-feet for the United States and about 500,000 acre-feet for Mexico. For the U.S. portion of the Rio Grande Basin, the low inflows during the 1950's reflect the severe drought that is considered the worst on record for the region. Mexican inflows since 1993 are among the lowest in the past 50 years, indicating the severity of Mexico's drought.

Water storage (million cubic meters) for the Amistad and Falcon International Reservoirs is shown in Figure 5. Water storage levels in both reservoirs declined significantly from 1992 to 1995, with capacities remaining nearly constant since 1996, but at their lowest levels in at least the past 30 years. The U.S. portion of the Amistad and Falcon combined reservoir storage fell to a record low of 19.1 percent of conservation capacity in August 1998 and has since remained at very low levels, according to the IBWC. Mexico's portion of the combined reservoir storage fell below 10 percent in April 2000, bottoming out near 7.5 percent later that year. As of February 16, 2002, the IBWC reported that the United States' combined holdings stood at 1.14 million acre-feet, or 1.41 million cubic meters (34.3 percent of





conservation capacity), while Mexico's holdings were 0.24 million acre-feet, or 0.30 million cubic meters (9.8 percent).

Water storage levels for two main reservoirs in Mexico (Boquilla and Venustiano Carranza) indicate water levels since January 1994 are also well below total storage capacity (Figures 6 and 7). Boquilla Reservoir was built during the Mexican revolution of 1910 and is Chihuahua's largest reservoir. The Venustiano Carranza Reservoir is located in the Mexican state of Coahuila.

### **Crop Production in the Rio Grande Basin**

Conference Report 107-275 requests that USDA estimate the value of the annual loss of U.S. agricultural production due to the deficit in Mexican water deliveries. H.R. Conf. Rep. No. 107-275, at 48-49 (2001) USDA is unable to quantify such losses for several reasons. First, the water deficit in Mexican deliveries could not be related to the annual surface water withdrawals by agricultural irrigators due to lack of data. Second, data on acreage planted to all crops, irrigated and dryland, is incomplete. For example, annual irrigated versus dryland acreage for corn is not available; annual vegetable acreage is not available; and annual citrus acreage is not available. Third, there are numerous confounding factors that have affected planted area in the region during the period of deficit deliveries. For example, poor yields even where water deliveries are not an issue can reduce planted area. Cotton provides an example.

Cotton underwent significant acreage changes during the period of Mexico's water delivery deficit. In 1995, drought across all of Texas dramatically reduced the state's cotton production, including in the Rio Grande Basin. The following year, in 1996, producers in the Rio Grande Basin reduced cotton acreage by 179,000 acres. However, for the rest of Texas, areas that do not depend on Rio Grande water, producers also reduced cotton acreage, by over 500,000 acres.

In addition to poor yields due to heat and drought, other factors have likely influenced planted area of crops in the Rio Grande Basin, including: insect losses; devastating freezes (affecting citrus); low crop prices, particularly following the runup in major crop prices in the mid - 1990's; rising farm production costs, especially in the mid - 1990's and in 2000 and 2001 due to high energy costs; economic development and competing uses for land; competition from horticultural imports from Mexico and other countries; and concerns over pesticide use and regulations. Reductions in production of one crop may also be offset by producers shifting to other crops. USDA does not have county-level econometric models that are able to decompose all of these factors into their individual contributions to value changes in crop production in the Rio Grande Basin.

Despite the limitations that prevent USDA from quantifying production value declines, insight on planted area and production effects in the Rio Grande Basin may be obtained by carefully examining all available data. The following sections assemble the data on acreage for crops in the Rio Grande Basin on both the U.S. and the Mexican sides.

#### **Rio Grande Basin in the United States**

Given the data limitations, USDA has examined area, yield, and production data for selected crops grown in the four counties of the lower Rio Grande Valley to analyze trends in recent years. The primary crops produced in these counties are citrus, vegetables, corn, cotton, sugarcane, sorghum, and forage crops. According to the 1997 Census of Agriculture, almost 40 percent of cropland was irrigated (Table 4). Data





include information on both irrigated and dryland area when available. The period of record ranges from 1990-2000 for cotton and sugarcane, 1990-2001 for corn and sorghum, 1992 and 1997 for vegetables,

**Table 4 – Census of Agriculture Data for Rio Grande Basin Counties, 1997**

Item	Cameron	Hidalgo	Starr	Willacy	Total
Farms (no.)	902	1,373	609	243	3,127
Cropland, harvested (1,000 acres)	191	345	64	211	811
Irrigated land (1,000 acres)	109	185	10	18	322
Value of crops sold (\$U.S. mil.)	70	181	21	45	317

Source: NASS/USDA, 1997 Census of Agriculture.

and 1981-2001 for citrus. Data for these crops are included in Appendix Tables 1-6. Irrigated area and yields have been affected by water availability, but other factors such as declining prices for some crops, conversion of land into non-agricultural uses, and idling of land under government programs have also affected planted area. In addition, imports from Mexico of competing products, such as melons and onions, have increased steadily in recent years and may have influenced producers' plantings (Appendix Table 7).<sup>1</sup>

### Cotton

Total planted area (irrigated and dryland) for cotton declined from a high of 401,000 acres in 1991 to 245,000 acres in 2000, reaching a low of 157,000 acres in 1997 (Figure 8). Irrigated cotton acreage declined significantly during the period, dropping from an average of 148,000 acres from 1990-95, to 82,400 acres from 1996-2000. Dryland cotton acreage also declined during the period, reaching a low of 93,000 acres in 1997. Dryland cotton acreage averaged 181,667 acres from 1990-95, declining to an average of 128,400 acres from 1996-2000. Dryland cotton acreage has increased in recent years, but still remains below the levels of the early 1990's. Total cotton production declined from 331,000 bales in 1990 to 280,000 bales in 2000. Yields have increased over the period, rising from 489 pounds per harvested acre in 1990 to 625 pounds per harvested acre in 2000. These increases in yield are greatest for dryland cotton.

Total harvested area (irrigated and dryland) for cotton is shown in Figure 9. Irrigated cotton area dropped from an average of 131,500 acres during 1990-95 to an average of 79,600 acres from 1996-2000. Dryland cotton acreage averaged 148,167 acres during 1990-95, falling to an average of 108,600 during 1996-2000. *It should be noted these averages are highly dependent on the placement of the 1995 year. If the data were grouped 1990-94 and 1995-2000, the calculated averages for harvested dryland cotton would become 165,400 acres and 100,833 acres, respectively. This would suggest a sharper drop in acreage from the former to later period.*

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<sup>1</sup> A study done by Texas A&M University attempted to relate the availability of Mexican water to a value of crop production and upstream economic activity associated with crop production (Robinson, 2000).





Percent abandonment (the difference between planted and harvested area) on dryland, irrigated, and total cotton area was calculated for the period 1990-2000 (Figure 10). Abandonment was highest during 1995, reaching 65, 34, and 50 percent on dryland, irrigated, and total cotton area, respectively. Abandonment has approached 20 percent in recent years on dryland cotton area.

Figure 11 shows cotton planted in the Southern Rio Grande Region relative to the preceding year farm price. The chart shows a strong relationship between price and planted acres during the first half of the 1990's. However, despite rising prices, planted area dropped significantly in 1996, following the disastrous production season in 1995, when a combination of adverse heat and dryness along with beet armyworms devastated the crop. Gross revenues from the crop dropped sharply from about \$115 million in 1994 to about \$25 million in 1995. Planted area began to recover in 1998, following good rains in 1997, but still remains below levels of the early 1990's. The slow recovery also partially reflects low cotton prices in recent years.

### Grain Sorghum and Corn

Total area planted to grain sorghum (irrigated and dryland) is shown in Figure 12, while total area planted to corn is shown in Figure 13. Data separating irrigated from dryland corn were not available.<sup>2</sup> On years when planted acreage for sorghum declined, planted acreage for corn usually increased, and vice versa. Planted area for both irrigated and dryland sorghum was lowest in 1990 and 1991, while planted acres for corn were the highest during these same years. Likewise, area planted to sorghum increased sharply in 1992, 1996, and 2000, while corn area declined sharply. Irrigated acreage for sorghum has increased during the period, rising from an average of 83,000 planted acres during 1990-95, to an average of 102,000 planted acres during 1996-2001. In contrast, planted dryland acreage has declined slightly, falling from a 289,167 acre average during 1990-95, to an average of 281,000 acres for the period 1996-2001.

### Sugarcane

Harvested area for irrigated sugarcane is shown in Figure 14. Harvested acreage fell from 43,500 acres in 1993 to a low of 27,300 in 1997. Harvested area rebounded in 2000, rising to 45,500 acres.

### Vegetables

Harvested area for all vegetables was obtained from county census information from 1992 and 1997. Harvested vegetable area (dryland and irrigated) declined from 68,069 in 1992 to 42,878 in 1997. Likewise, harvested irrigated acres declined sharply from 62,559 in 1992 to 35,007 in 1997. This sharp decline may be due in part to excessive rain during the fall of 1997, although water shortages, economic development, pesticide regulations, and increasing imports likely played a role.

### Citrus

Data on Texas orange production, all of which is grown in the lower Rio Grande Basin, for the period 1981-2001 are shown in Figure 15. The data show the high vulnerability of Texas citrus production to potential freeze damage. A sharp drop in orange production occurred after the severe freezes of

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<sup>2</sup> According to the Census of Agriculture, corn area was irrigated on 19,974 acres in 1992 and 20,776 acres in 1997.





December 1983 and December 1989. No oranges were produced during the seasons of 1984-85 and 1990-91, years that immediately followed these episodes. Furthermore, only modest amounts of oranges were produced during 1985-86 and 1991-92, the second year following the freezes. Citrus production has rebounded slowly in recent years to levels obtained prior to the 1989 freeze, but remains well below production levels of the early 1980's.

#### Summary of Changes in Crop Area and Production in U.S. Rio Grande Basin

An assessment of the data presented above suggests that insufficient water likely played an important role in cropping choices of Rio Grande Basin producers. Although definitive conclusions are not possible given the data limitations and the many confounding factors, several indicators suggest water delivery deficits may have had their most pronounced effect during the late 1990's. During this period, the data reviewed indicate that, except for 1997, annual average precipitation was well below normal; water inflows to the Rio Grande above the Amistad and Falcon reservoirs were unusually low, especially on the Mexican side; water storage levels in the Amistad and Falcon reservoirs hit the lowest levels in three decades beginning in 1995 and continuing through the current period; and water application rates as measured in acre-feet of irrigation water applied per acre fell to levels well below the average of the mid-1990's (Table 5).

**Table 5 – Irrigated Acres and Acre-feet of Water Used, Rio Grande Basin**

Year	Irrigated acres	Acre-feet	Ratio	Year	Irrigated acres	Acre-feet	Ratio
1992	720,850	693,767	0.96	1996	612,505	783,465	1.28
1993	638,165	964,491	1.51	1997	563,390	634,809	1.13
1994	760,133	1,384,903	1.82	1998	562,127	674,095	1.20
1995	710,388	1,186,713	1.67				

Source: Texas Water Development Board.

Coinciding with these atypical meteorological and hydrological events, the cumulative deficit of Mexican water deliveries rose from 0.5 million acre-feet at the end of 1995 to 1.4 million acre-feet by the end of 1999. Harvested acreage of field crops for which data are available (cotton, sorghum, corn and sugarcane) in the Rio Grande Basin fell sharply during the 1996-99 period, compared with earlier periods, but then began to rise toward earlier levels in 2000 (Table 6). Therefore, focusing on the 1996-1999 period, total harvested acreage of field crops in the Rio Grande Basin averaged 616,000 acres, down 15 percent from the 728,000 acres averaged during 1990-95. Irrigated acreage in the Rio Grande Basin fell 17 percent to 208,000 from 251,000. Based on the Texas state season-average farm prices for the field crops during 1996-99, the annual average value of the decline in production of field crops during 1996-99 compared with 1990-95 was \$34 million. (This is calculated by crop as average production during 1990-95 minus average production during 1996-99 multiplied by Texas season-average farm price during 1996-99.) Lack of data prevents development of loss estimates for other crops.

An important consideration when interpreting the above declines in acreage and production value during 1996-99 is that factors other than water supplies were also influencing acreage and production decisions.





As noted earlier in this report, these factors include: production loss experiences from earlier years due to weather; insect losses; freezes (citrus); low crop prices, particularly following the runup in major crop prices in the mid 1990's; rising farm production costs, particularly in the mid 1990s and in 2000 and 2001 due to high energy costs; economic development

**Table 6 – Area Harvested for Major Crops in the Rio Grande Basin**

Marketing year	Harvested area <u>1/</u>	Dryland <u>2/</u>	Irrigated		
			Field crops <u>3/</u>	Corn and vegetables	Total
	1,000 acres				
1990	712.4	388.6	208.8	NA	NA
1991	768.2	340.0	298.2	NA	NA
1992	758.7	500.0	221.7	82.5	304.2
1993	788.5	491.0	242.5	NA	NA
1994	754.4	429.0	289.4	NA	NA
1995	584.2	303.0	243.2	NA	NA
1996	646.6	384.0	240.6	NA	NA
1997	543.8	301.0	184.3	55.8	240.1
1998	602.5	333.0	208.0	NA	NA
1999	673.0	408.0	198.0	NA	NA
2000	709.0	420.5	225.0	NA	NA

1/ Includes irrigated and dryland for cotton, corn, sorghum, and sugarcane.

2/ Includes cotton and sorghum only.

3/ Includes cotton, sorghum, and sugarcane (assumes all sugarcane area is irrigated).

Source: TASS. See appendix tables 1-6.

and competing uses for land; competition from horticultural imports from Mexico and other countries; and concerns over pesticide use and regulations. Finally, if lack of irrigation water had been the only reason for the decline in acreage during 1996-99, one would have expected to see an increase in dryland acreage as producers shifted from irrigated to dryland practices. However, dryland acreage of the major field crops also fell during 1996-99, and the share of dryland acreage in total harvest acreage remained about the same in 1996-99 as in 1990-95. In addition, citrus production was generally rising during the 1990's in the Rio Grande Basin, which appears to have competed for water with field and other horticultural crops.





## Rio Grande Basin in Mexico

In Mexico, the Rio Grande Basin (called the Rio Bravo in Mexico) includes portions of Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas states. Primary crops grown on the Mexican side of the basin include cotton, corn, sorghum, winter grains, dry beans, sugarcane, citrus, vegetables, pecans, and alfalfa. Crop area for cotton, sorghum, corn for grain, alfalfa hay, and pecans were examined for the four Mexican states. The total crop area for Chihuahua, Coahuila, and Nuevo Leon is roughly equal to that of Tamaulipas. However, while there is significant crop land along the Rio Grande in northern Tamaulipas, more than 80 percent of that state is not part of the Rio Grande Basin.

### Cotton

Total planted cotton area (irrigated and dryland) for the four Mexican states has declined during the past 10 years, due mostly to a significant decrease in dryland cotton area since 1996 (Figure 16). Irrigated cotton area averaged 54,472 hectares from 1990-95, rising to an average of 63,187 hectares from 1996-2000. However, irrigated area fell sharply in 1999 and 2000 to around 40,000 hectares. Dryland cotton area fell from an average of 41,635 hectares during 1990-95 to an average of 16,513 hectares from 1996-2000.

### Grain Sorghum and Corn

Total area (irrigated and dryland) planted to sorghum and corn is shown in Figures 17 and 18. The graphs reveal similar patterns to that observed in the area data for sorghum and corn for the United States. Increases in planted area for sorghum are usually associated with declines in corn area and vice versa. Total area planted to corn declined from a high of 965,073 hectares in 1994 to a low of 387,285 in 2000 (Figures 17 and 18). These declines occurred in both irrigated and dryland corn area. In contrast, sorghum area increased from 604,857 hectares in 1993, to 1,185,386 hectares in 2000. This increase was largely due to increases in dryland area. Irrigated sorghum area decreased by 50 percent, falling from a high of around 200,000 hectares in the early 1990's, to lows of about 90,000 hectares in 1999 and 2000.

### Annual and Perennial Crops

Area data for annual and perennial crops in the Mexican portion of the Rio Grande Basin indicate that dryland area has increased in recent years, while irrigated area has declined since the middle 1990's (Figure 19). However, the decline in irrigated area is greatest in Tamaulipas, with only modest declines in the other three states.

### Alfalfa and Pecans

In the state of Chihuahua, total planted area increased during the 1990's for high-value crops such as alfalfa hay and pecans (Figure 20). All the area planted to these crops is irrigated. For pecans, area has steadily increased during the 1990's, rising from an average of around 18,000 hectares in the early 1990's to more than 26,000 hectares in 2000, a 45-percent increase. Although area planted to alfalfa hay declined from 1990 to 1996, a sharp increase has occurred since then. Area planted to alfalfa reached 53,601 hectares in 2000, increasing 14 percent from 1990. Although alfalfa is highly adaptive to various climatic and soil conditions, yields drop sharply in periods of drought. Because alfalfa requires more water than most field crops, it must be heavily irrigated.





## Summary of Changes in Crop Area in the Mexican Rio Grande Basin

An assessment of the data presented above suggests that insufficient water likely played an important role in cropping choices of Rio Grande Basin producers in Mexico, as it did in the United States. As for the U.S. assessment, definitive conclusions are not possible given the data limitations and the many confounding factors. Several indicators suggest water supply problems had more significant effects during the late 1990's, compared with earlier years. During this period, annual average precipitation was well below normal in Mexico; water inflows to the Rio Grande above the Amistad and Falcon reservoirs were unusually low, especially on the Mexican side; and water storage levels in the Boquilla and Venustiano Carranza reservoirs were well below capacity.

Irrigated corn and sorghum planted area and annual and perennial crop planted area data all suggest declines in the late 1990's compared with the early 1990's for Mexican states bordering the Rio Grande. However, area planted to pecans and alfalfa increased in the late 1990's compared with the early 1990's. The area planted to pecans and alfalfa was relatively small compared with field crops, although alfalfa is a heavy water user.

## **USDA Authorities and Assistance to the Rio Grande Valley**

USDA has a broad range of authorities vested in different agencies that are used to respond to natural disasters, including drought. This response capability includes technical and financial assistance, consultation and analysis, technology transfers, and landscape restoration. These functions reside primarily in the Natural Resources Conservation Service (NRCS), the Risk Management Agency (RMA), and the Farm Service Agency (FSA). These authorities have been used in recent years to respond to the drought and loss of water in the Rio Grande Basin.

### Natural Resources Conservation Service

NRCS administers several programs designed to enhance conservation of marginal lands and address resource concerns, including the Wetlands Reserve Program (WRP), the Watershed Protection and Flood Prevention Program, the Wildlife Habitat Program, the Environmental Quality Incentives Program, and the Farmland Protection Program. NRCS is currently involved in several projects in the Rio Grande Basin under the WRP and the Watershed Program.

#### Wetlands Reserve Program

The WRP is a voluntary program to restore and protect wetlands on private property, which provides an opportunity for landowners to receive financial incentives to enhance wetlands in exchange for retiring marginal agricultural land. Under the WRP, there are two permanent easements in Cameron County to restore wetlands, covering 17,000 acres, with total Federal outlays of \$1.7 million.

#### Watershed Protection and Flood Prevention Program

This program works through local government sponsors to help participants solve natural resource and related economic problems on a watershed basis. Projects include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds of 250,000 or fewer acres. Both technical





and financial assistance are available. NRCS has three authorized projects in the lower Rio Grande Basin under this program, two of which are completed. The third needs an additional \$9.8 million to complete. Total benefits from the three projects, including both agricultural and non-agricultural benefits, are estimated at \$18.6 million.

#### Environmental Quality Incentives Program (EQIP)

EQIP provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program is funded through the Commodity Credit Corporation. The purposes of the program are achieved through the implementation of a conservation plan that includes structural, vegetative, and land management practices on eligible land. Five- to ten-year contracts are made with eligible producers. Cost-share payments may be made to implement one or more eligible structural or vegetative practices, such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat. Incentive payments can be made to implement one or more land management practices, such as nutrient management, pest management, and grazing land management.

NRCS currently funds an EQIP project in the South Laguna Madre watershed, which is located in the lower Rio Grande Basin in the counties of Cameron, Hidalgo, and Willacy. According to NRCS data, 56 percent of 1,783,245 acres in the watershed are in cropland use (997,240 acres). Of this share, 72 percent is irrigated with a total consumptive use of 9.75 million gallons of water per day. Because of the variety of citrus and vegetables grown in the region, the number of different chemicals used are greater than in any part of the country. The EQIP program aims to address water quality issues. Over \$1 million has been spent on EQIP programs in the lower Rio Grande since 1999 (Table 10).

#### Cooperation with Bureau of Reclamation

In 1997 the Bureau of Reclamation of the Department of Interior established a Water Conservation Field Services Program (WCFSP) to work with local water districts and others to actively encourage water conservation and to encourage more efficient use of water supplies. In July 1998, the Bureau, through the WCFSP, initiated a "Bridging the Headgate" partnership with NRCS, the National Association of Conservation Districts, and the National Association of State Conservation Agencies. Subsequently, the Western States Water Council and the National Water Resources Association also joined the partnership. The objective of the partnership is to create new opportunities for collaboration and synergism between traditional on-farm and off-farm conservation assistance programs to promote efficient agricultural water management.

Various water conservation activities have been launched in western States as part of the "Bridging the Headgate" partnership, including in the Lower Rio Grande Basin. Since December 1999, staff from the Bureau and NRCS have been working together in assessing local conservation issues, water management practices, and water supply infrastructure needs. The two agencies and three Soil and Water Conservation Districts sponsored the Lower Rio Grande Valley Water Management Workshop in September 2000 that included 26 irrigation districts. Through a staffing agreement with the Harlingen Irrigation District, NRCS shared the costs of an irrigation engineer position to work on water management issues in the district. Further collaboration between the agencies has continued as they evaluate follow-up activities.





### Risk Management Agency

The primary responsibility of the Risk Management Agency (RMA) is to administer the Crop Insurance Program. The program provides a safety net by protecting producers against a wide range of environmental risks as well as the risk of price fluctuations. Participation in the Crop Insurance Program by producers is voluntary; however, participation is encouraged through premium subsidies. Crop insurance is delivered to producers through private insurance companies that share in the risk of loss. The companies are reimbursed for their delivery expenses and receive underwriting gains in years when crop losses are low.

Through the Federal Crop Insurance Corporation, RMA has paid out indemnities in recent years on many commodities in the Rio Grande Basin (Table 7). The largest indemnities have been paid on cotton, grain sorghum, and onions. Net indemnities to producers are calculated as the indemnity paid, plus any subsidies and premium discounts, minus the premium paid by producers.

**Table 7 – Net Indemnities Under Crop Insurance Programs (\$ mil.)**

County	1999	2000	2001
Cameron	2.3	3.9	7.2
Hidalgo	25.2	6.6	6.8
Starr	1.6	1.4	1.8
Willacy	-0.4	-0.8	13.6
TOTAL	28.2	11.3	29.4

Source: RMA/USDA.

### Farm Service Agency

FSA provides assistance to farmers and ranchers for natural disasters and emergencies through several programs. The Emergency Conservation Program (ECP) provides emergency cost-share funding for farmers to assist in rehabilitating eligible farmlands damaged by natural disasters that would create new conservation problems if left untreated. During severe drought, ECP also provides emergency water assistance both for livestock and for existing irrigation systems for orchards and vineyards. FSA's Noninsured Crop Disaster Assistance Program (NAP) provides financial assistance to eligible producers affected by natural disasters. This federally funded program covers noninsurable crop losses and planting prevented by disasters. Haying and grazing of certain Conservation Reserve Program acreage may be made available in areas suffering from weather-related natural disaster. In addition, emergency disaster assistance for both crops and livestock has been made available in recent years to eligible areas. The four counties in the Rio Grande Basin have received payments under these emergency programs in recent years (Table 8).

FSA provides low-interest emergency (EM) loan assistance to eligible farmers to help cover production and physical losses in counties declared as disaster areas by the President or designated by the Secretary of Agriculture. In order to be declared eligible for EM loans, a crop loss must exceed 30 percent of the





historical value of the crop. Crop losses are estimated based on a 5-year average yield, a 3-year average price, and the affected crop area for the year in question. The value of the crop loss is only for the one crop and is not an estimate of total crop losses for a county. The prices may not correspond with market prices, but are used by FSA for purposes of determining eligibility for the EM loans. The current yield is a key indicator of the extent of the loss.

**Table 8 – Payments to Rio Grande Basin Under FSA Emergency/Disaster Programs**

Program	1999	2000	2001	2002 (p)
	<i>\$U.S. millions</i>			
Crop Disaster Program	0	8.4	11.2	0.4
Crop Loss Disaster Assistance	24.1	0.4	–	0
Disaster Reserve Assistance	0	–	0	0
Emergency Conservation	–	0	–	0
Livestock Emergency Assistance	0.9	0	0.8	0
Noninsured Assistance Program	0.1	0	0	0
Pasture Recovery Program	0	0	0.3	–
<b>TOTAL</b>	<b>24.2</b>	<b>8.8</b>	<b>12.5</b>	<b>0.4</b>

(p) preliminary. – less than \$100,000. Source: USDA/FSA.

The four Rio Grande counties have been declared disaster areas several times since 1996, making emergency loan assistance available for eligible recipients. FSA data shows the nature of the disaster and the estimated value of the loss for the affected crop (Table 9). Following these disaster declarations, 11 emergency loans were made to the four counties in 1999, none in 2000, and four in 2001. Cameron and Hidalgo counties have been the main users of the loan program.

In addition to emergency and disaster payments, the four counties have received payments under ongoing USDA programs, including commodity, conservation, and market loss programs (Table 10). Under commodity programs for program crops, which includes corn, sorghum, and cotton, loan deficiency payments, marketing loan gains, market loss assistance, and production flexibility contract payments have been made to eligible producers.

The Conservation Reserve Program (CRP) is a voluntary program for agricultural landowners, where landowners can receive annual rental payments and cost-share assistance to establish long-term, resource conserving covers on eligible farmland. The Commodity Credit Corporation (CCC) makes annual rental payments based on the agriculture rental value of the land, and it provides cost-share assistance for up to 50 percent of the participant's costs in establishing approved conservation practices. Participants enroll in CRP contracts for 10 to 15 years. In 2002, land idled under the CRP in the four counties equaled 86,692 acres.



**Table 9 — Farm Service Agency Disaster Declarations to the Rio Grande Counties Under the Emergency Loan Assistance Program**

Date	County	Crop	Event	Yields/Acre <sup>1/</sup>		Estimated Loss \$ mil.
				Avg.	Current	
4/1 - 6/30/97	Starr	Watermelon	Excessive rain	131.0	54.4	5.4
3/1 - 4/30/97	Cameron	Corn	Excessive rain	88.4	50.0	1.7
3/1 - 4/30/97	Hidalgo	Onions	Excessive rain	240.6	117.9	24.0
1/1 - 6/15/98	Cameron	Native, improved pasture <sup>2/</sup>	Drought	2.5	1.0	17.9
1/1 - 6/6/98	Starr	Hay-grazer	Drought	1.8	0.1	76.5
3/1 - 6/25/98	Willacy	Sorghum	Drought	35.7	14.0	9.4
1/1 - 10/20/00	Cameron	Native grass	Drought	2.5	1.5	12.8
1/1 - 10/20/00	Hidalgo	Sorghum	Drought	43.4	28.0	5.6
1/1 - 10/20/00	Willacy	Native grass	Drought	1.75	0.4	25.5
2/1 - 2000*	Starr	Cotton <sup>3/</sup>	Drought	321.0	105.0	3.4
10/1/00 - 5/31/01*	Willacy	Pasture	Drought	1.8	0.3	30.9
1/1/01*	Starr	Cotton <sup>4/</sup>	Drought	450.0	150.0	4.0
1/1/01*	Hidalgo	Native pasture	Drought	1.3	0.5	17.3

<sup>1/</sup> Units vary by commodity. <sup>2/</sup> Yields for native pasture only. <sup>3/</sup> Non-irrigated only. <sup>4/</sup> Irrigated only. \* Ongoing designation. Source: USDA/FSA.





**Table 10 – Payments to Rio Grande Basin Under USDA Programs (\$ mil.)**

Program	1999	2000	2001	2002
Conservation Reserve Program	3.7	3.6	3.7	3.6
CRP Cost-Shares	0.2	0.3	0.2	–
EQIP	0.3	0.3	0.4	0.1
Loan Deficiency Payments	12.5	8.3	5.6	1.2
Marketing Gains	0	0.8	–	–
Marketing Loss Assistance	10.4	39.7	17.6	–
Production Flexibility	20.2	18.3	15.6	11.4
Other	–	–	0.2	0.8
<b>TOTAL</b>	<b>47.5</b>	<b>71.5</b>	<b>43.5</b>	<b>17.1</b>

2002 are payments to date. – less than \$100,000.

Source: USDA/FSA.

### **Conclusions and Suggested Future Actions**

Conference Report 107-275 requests that the USDA estimate the value of the annual loss of U.S. agricultural production due to the deficit in Mexican water deliveries. USDA is unable to quantify such losses for several reasons, including lack of data. USDA does not have county-level econometric models that are able to decompose all of the many factors, including weather, water availability, and prices, into their individual contributions to value changes in crop production in the Rio Grande Basin.

Despite the limitations that prevent USDA from quantifying production value declines, insight on planted area and production effects in the Rio Grande Basin may be obtained by carefully examining all available data. An assessment of the available data suggests that insufficient water likely played an important role in cropping choices of Rio Grande Basin producers. Although definitive conclusions are not possible given the data limitations and the many confounding factors, several indicators suggest water delivery deficits may have had their most pronounced effect during the late 1990's.

The cumulative deficit of Mexican water deliveries rose from 0.5 million acre-feet at the end of 1995 to 1.4 million acre-feet by the end of 1999. Harvested acreage of field crops for which data are available (cotton, sorghum, corn and sugarcane) in the Rio Grande Basin fell sharply during the 1996-99 period, compared with earlier periods, but then began to rise toward earlier levels in 2000. Therefore, focusing on the 1996-1999 period, total harvested acreage of field crops in the Rio Grande Basin averaged 616,000 acres, down 15 percent from the 728,000 acres averaged during 1990-95. Irrigated acreage in the Rio Grande Basin fell 17 percent to 208,000 from 251,000. Based on the Texas state season-average farm prices for the field crops during 1996-99, the annual average value of the decline in production of field crops during 1996-99 compared with 1990-95 was \$34 million. Lack of data prevents development of loss estimates for other crops.





USDA has been actively engaged in the Rio Grande Basin through its emergency and disaster programs, as well as with ongoing commodity support programs. Programs such as the Wetland Reserve Program and the Conservation Reserve Program have combined to take over 100,000 acres of land out of production since 1996 to help meet conservation and environmental goals. USDA will continue to provide support to the region to assist in addressing both short-term water and weather emergencies, as well as longer-term efforts to address water availability and quality.

With regard to longer term efforts, there may be scope for further collaboration between USDA and the Bureau of Reclamation. For example, in December 2000, the U.S. Congress approved and the President signed into law the Lower Rio Grande Valley Water Resources Conservation and Improvement Act of 2000, Pub. L. No. 106-576, which directs the Secretary of the Interior, through the Bureau of Reclamation, to conserve and enhance the water supplies of the Lower Rio Grande Valley. The legislation authorizes the Secretary of the Interior, through specified projects that meet the review criteria and project requirements, to conduct or participate in funding engineering work, infrastructure construction, and improvements for conserving and transporting raw water. The legislation authorizes appropriations of \$2 million for project planning and \$10 million for project implementation. Under this legislation and current efforts such as the “Bridging the Headgate” partnership, USDA may be able to further contribute to long-term solutions to water supply needs and conservation in the Rio Grande Basin.

USDA is committed to ensuring that the full range of existing loan, grant, payment and technical assistance programs it administers are available to eligible producers in the Rio Grande Basin. USDA will continue to ensure that these programs are timely administered and responsive to the needs of producers in the area. In addition, the Secretary of Agriculture and USDA staff would be pleased to work with members of Congress, producers and other interested parties regarding possible additional effective efforts to help mitigate the effects of drought and insufficient irrigation water supplies in the Rio Grande Basin.

### References

*Rio Grande Regional Water Plan (Region M)*. 2001. Adopted by the Rio Grande Regional Water Planning Group (RGRWPG) and approved by the Texas Water Development Board (TWDB).

Robinson, J. 2000. *The Value Of Applied Irrigation Water And The Impact Of Shortages On Rio Grande Valley Agriculture, 2001*. The Department of Agricultural Economics, Texas A&M University and the Texas Water Development Board.



# Rio Grande Basin

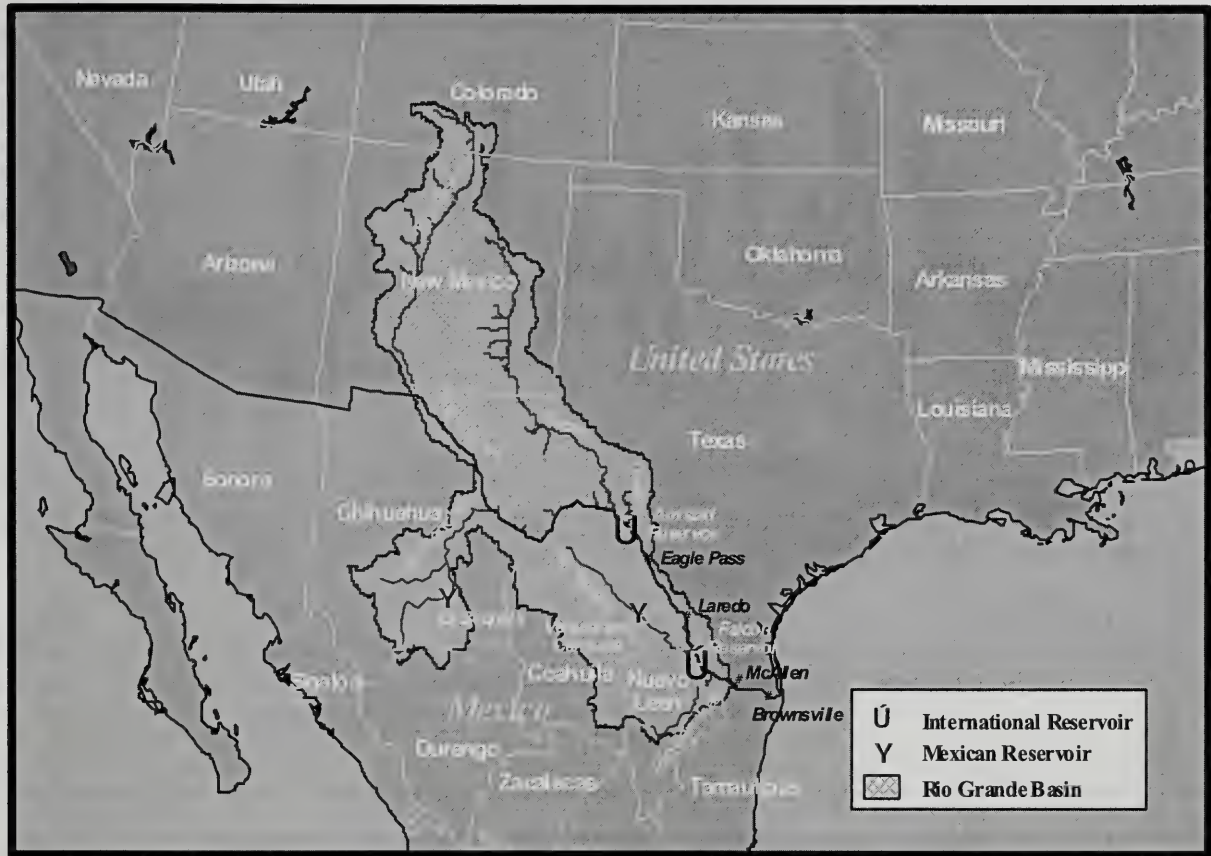


Figure 1

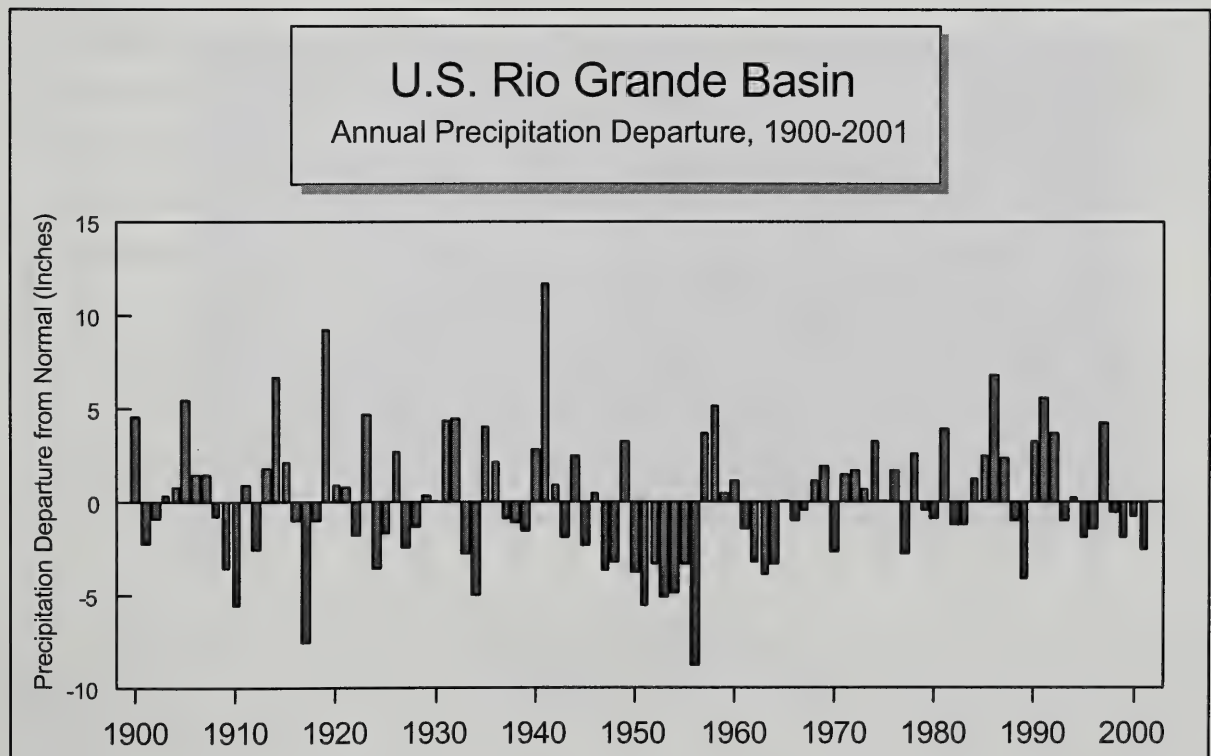


Figure 2

Source: Data supplied by NOAA/NESDIS/NCDC





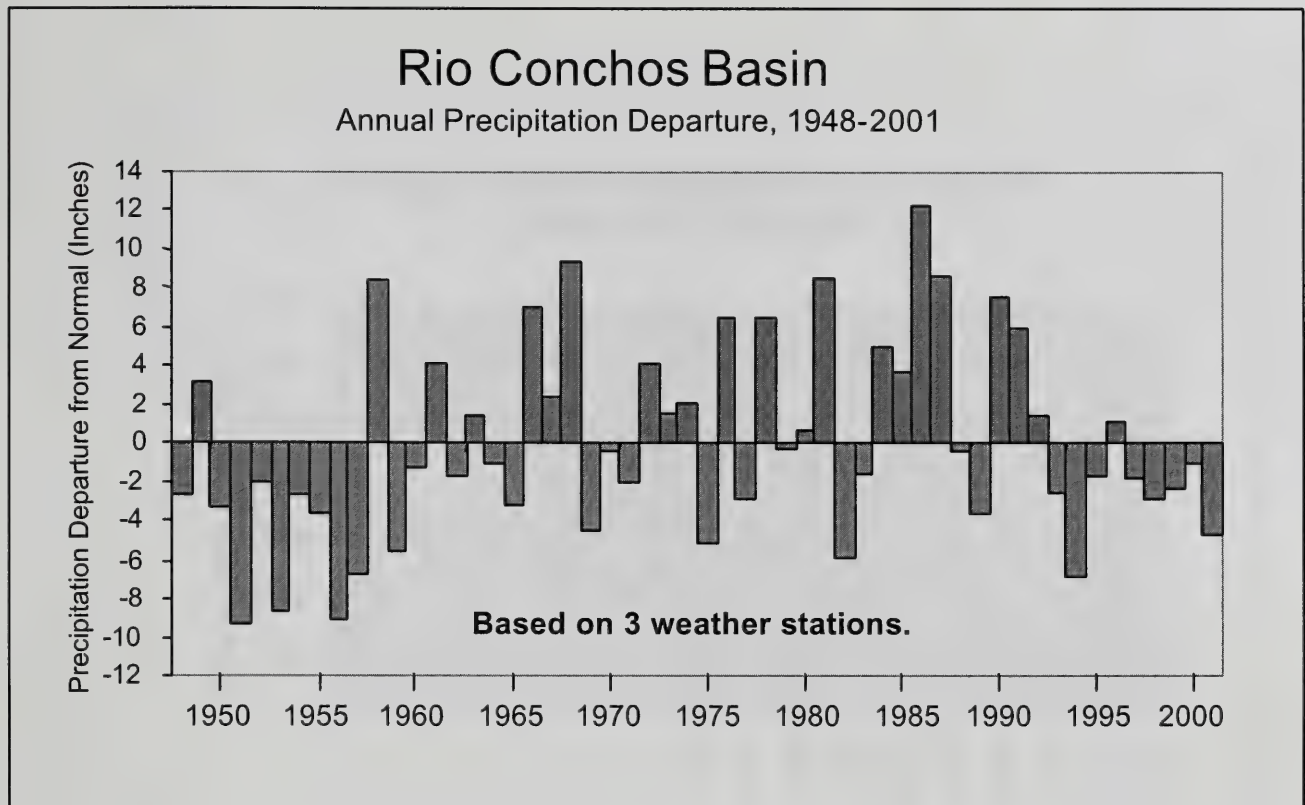


Figure 3

Source: Weather data provided by the Mexican National Water Commission (CONAGUA) and the Mexican National Weather Service.

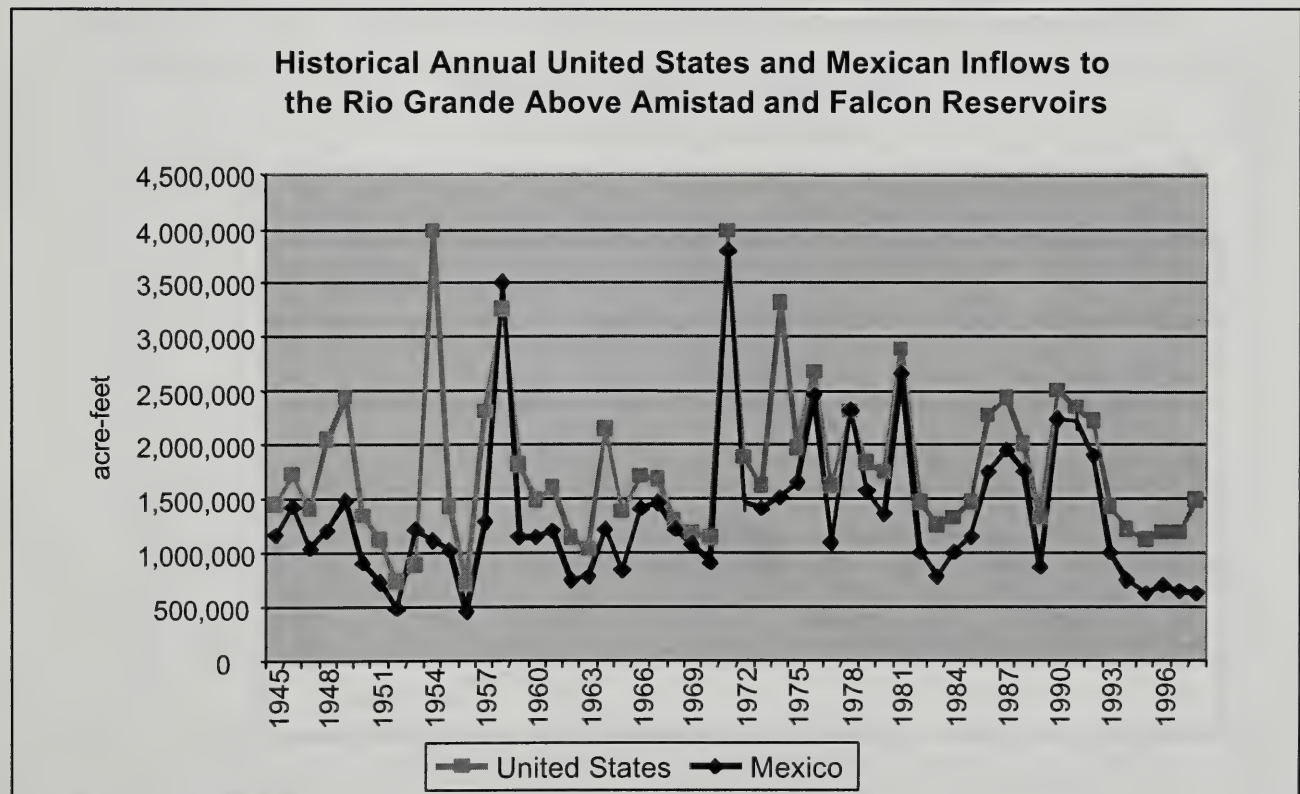


Figure 4

Source: Rio Grande Regional Water Plan (January, 2001)





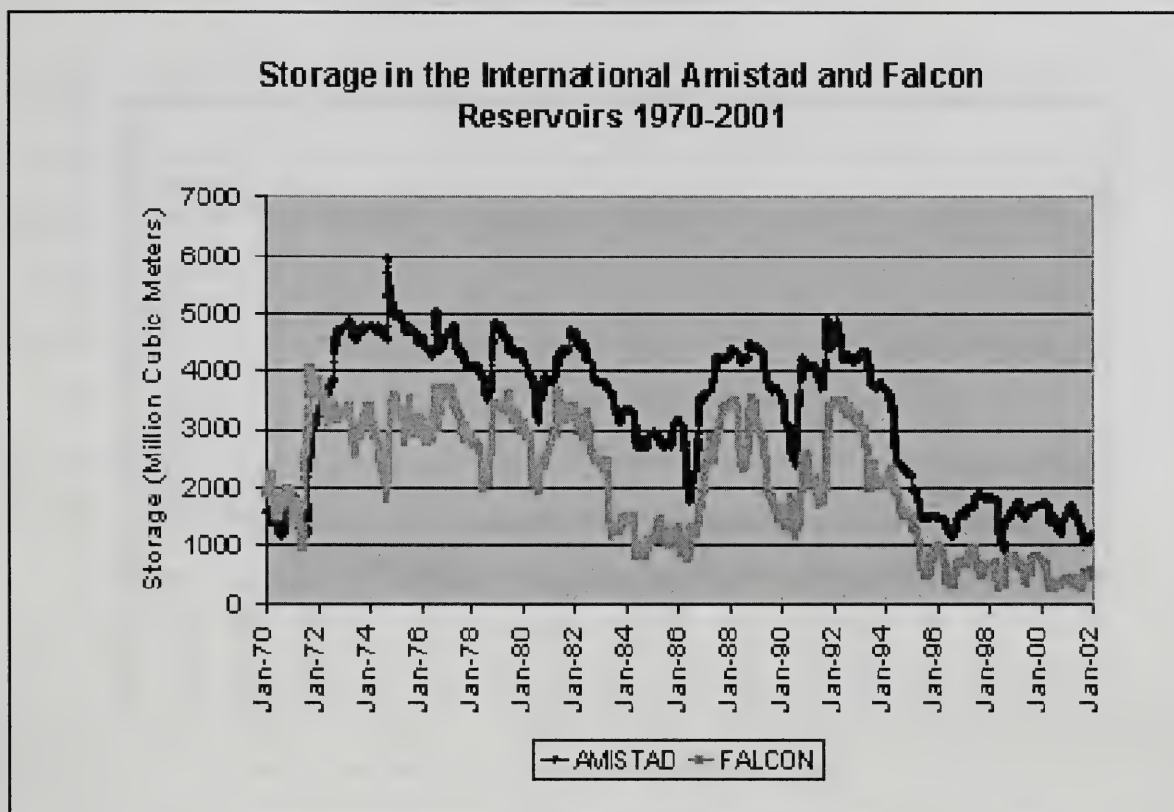


Figure 5 Source: Data courtesy of the International Boundary and Water Commission (IBWC)

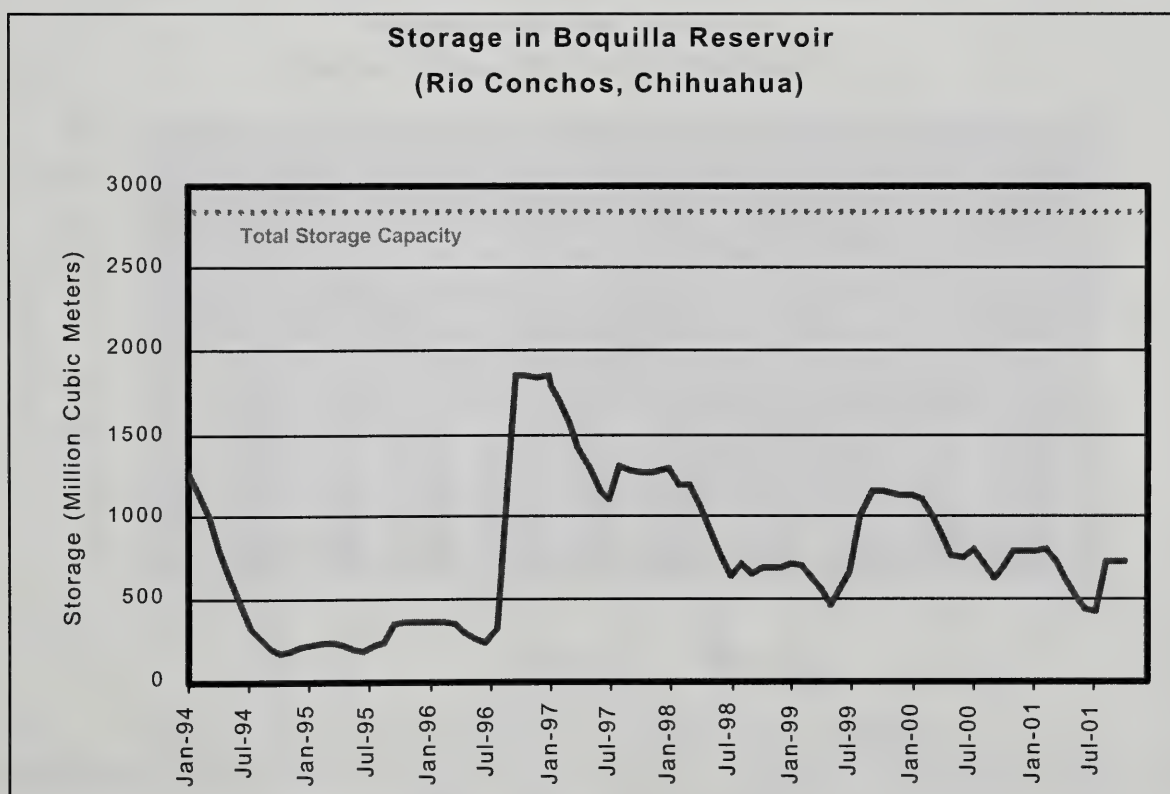


Figure 6 Source: Mexican Center of Agricultural Statistics (CEA)



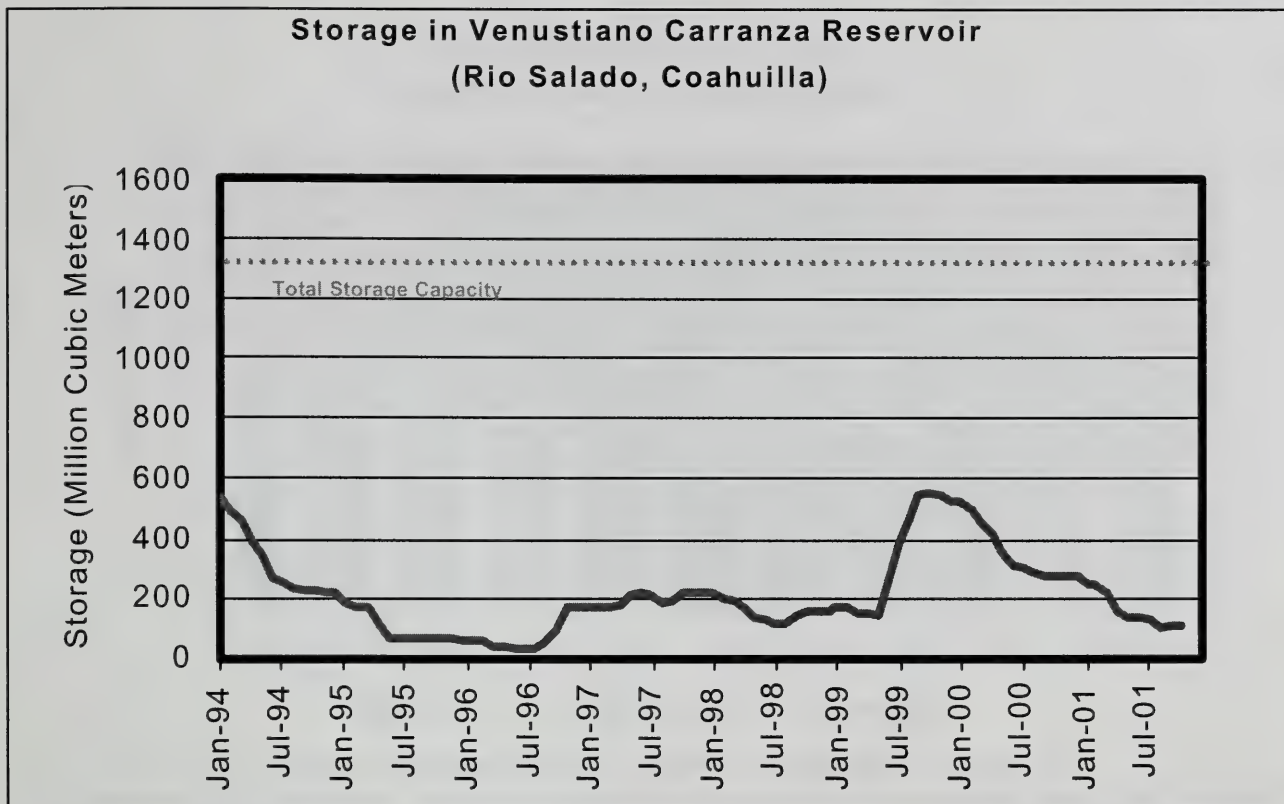


Figure 7

Source: Mexican Center of Agricultural Statistics (CEA)

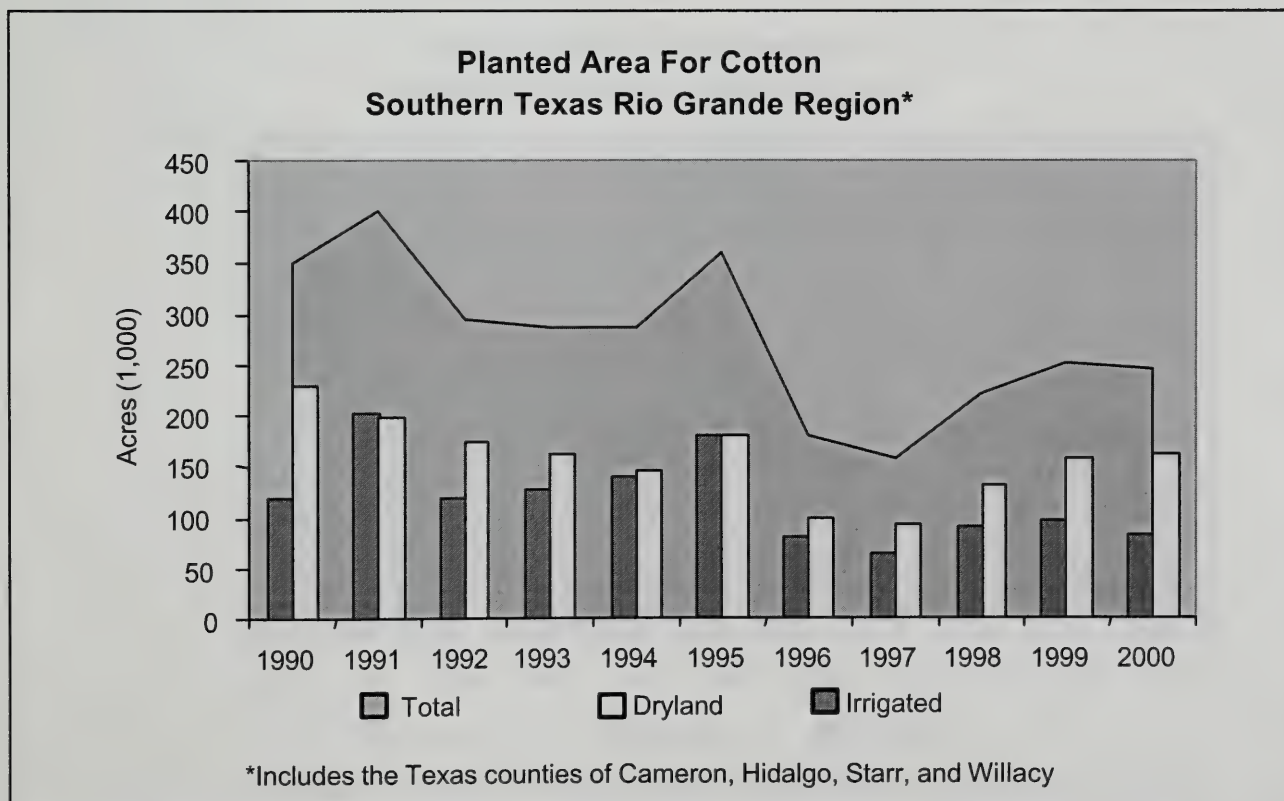


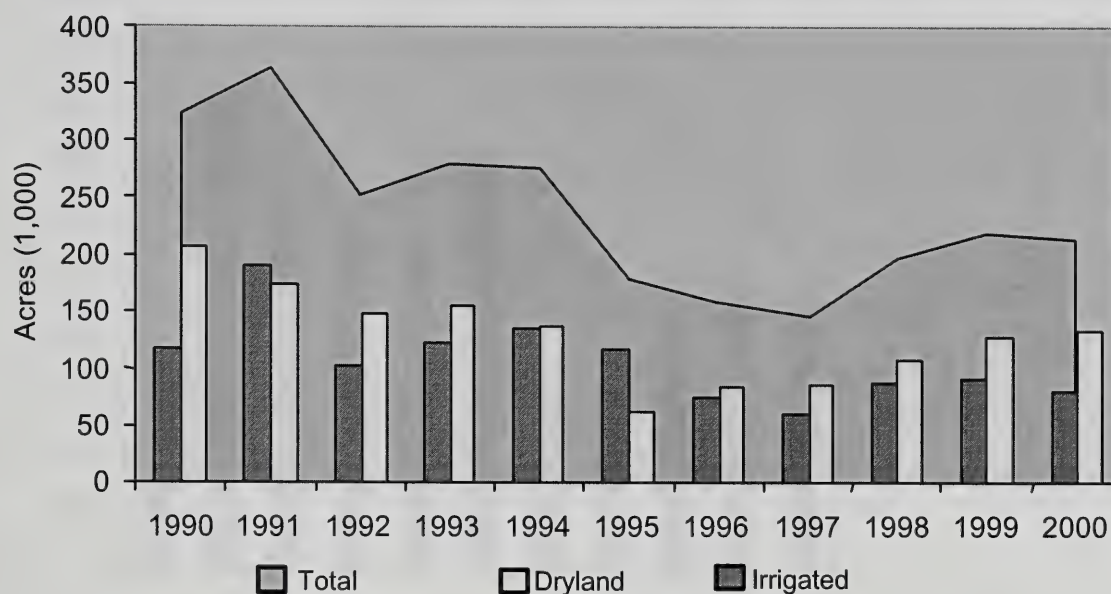
Figure 8

Source: Texas Agricultural Statistics Service (TASS)





### Harvested Area For Cotton Southern Texas Rio Grande Region\*

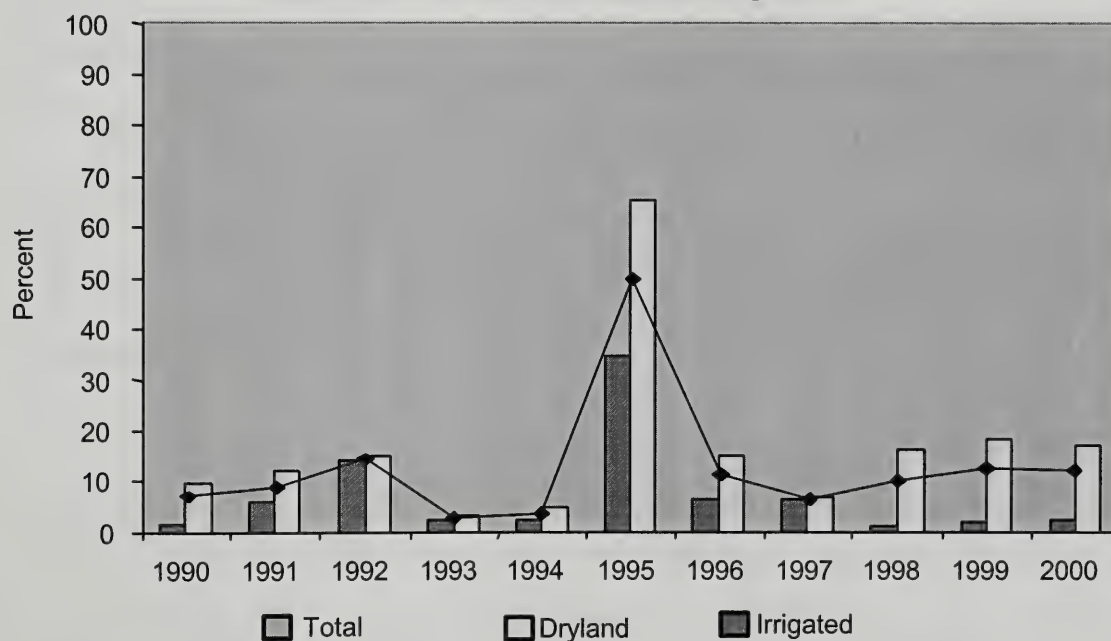


\*Includes the Texas counties of Cameron, Hidalgo, Starr, and Willacy

Figure 9

Source: Texas Agricultural Statistics Service (TASS)

### Percent Cotton Abandonment Southern Texas Rio Grande Region\*



\*Includes the Texas counties of Cameron, Hidalgo, Starr, and Willacy

Figure 10

Source: Texas Agricultural Statistics Service (TASS)

THE EFFECT OF TEMPERATURE ON THE  
RATE OF REACTION BETWEEN  
SODIUM HYDROXIDE AND  
SODIUM CARBONATE



Fig. 1. The effect of temperature on the rate of reaction between sodium hydroxide and sodium carbonate. The rate of reaction increases with temperature, with a slight dip at 40°C.

The rate of reaction between sodium hydroxide and sodium carbonate increases with temperature. This is due to the fact that the molecules have more kinetic energy at higher temperatures, and therefore they are more likely to collide with sufficient energy to overcome the activation energy barrier.



Fig. 2. The effect of concentration on the rate of reaction between sodium hydroxide and sodium carbonate. The rate of reaction increases with concentration, with a slight dip at 0.4 mol/l.

The rate of reaction between sodium hydroxide and sodium carbonate increases with concentration. This is due to the fact that there are more reactant molecules present in a given volume at higher concentrations, and therefore there are more collisions between them.



### Lagged Upland Cotton Farm Price & Southern Rio Grande Cotton Planted Area

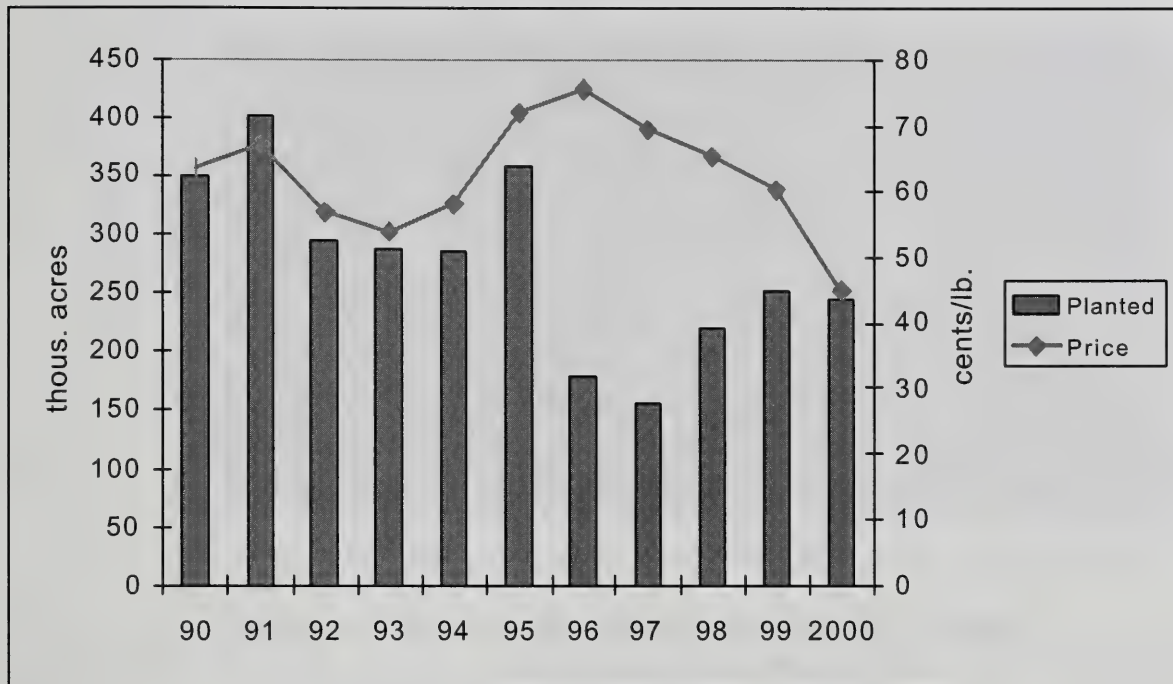
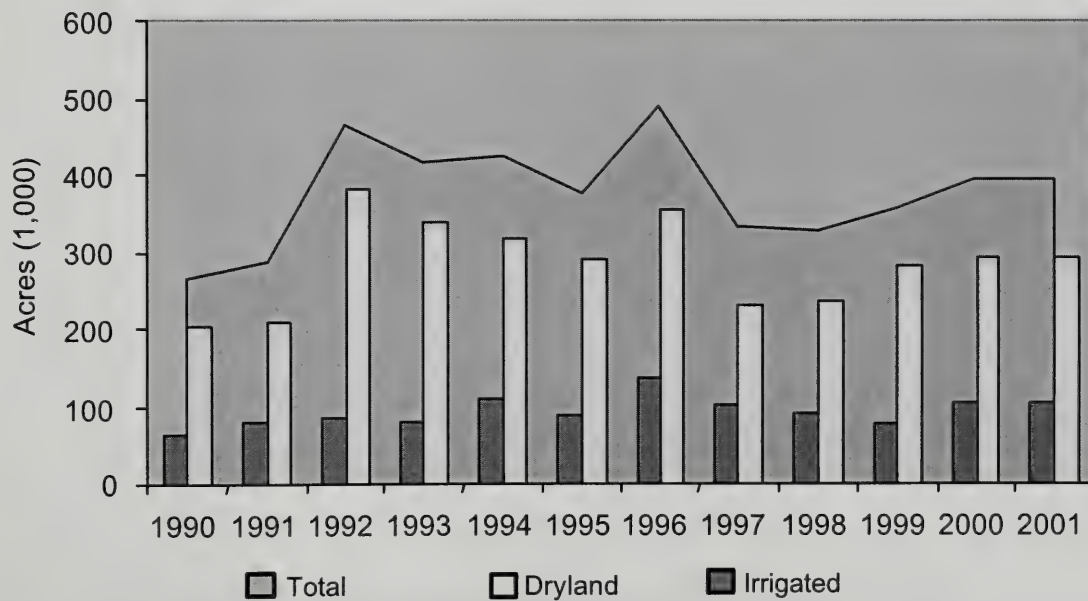


Figure 11

### Planted Area For Sorghum Southern Texas Rio Grande Region\*



\*Includes the Texas counties of Cameron, Hidalgo, Starr, and Willacy

Figure 12

Source: Texas Agricultural Statistics Service (TASS)



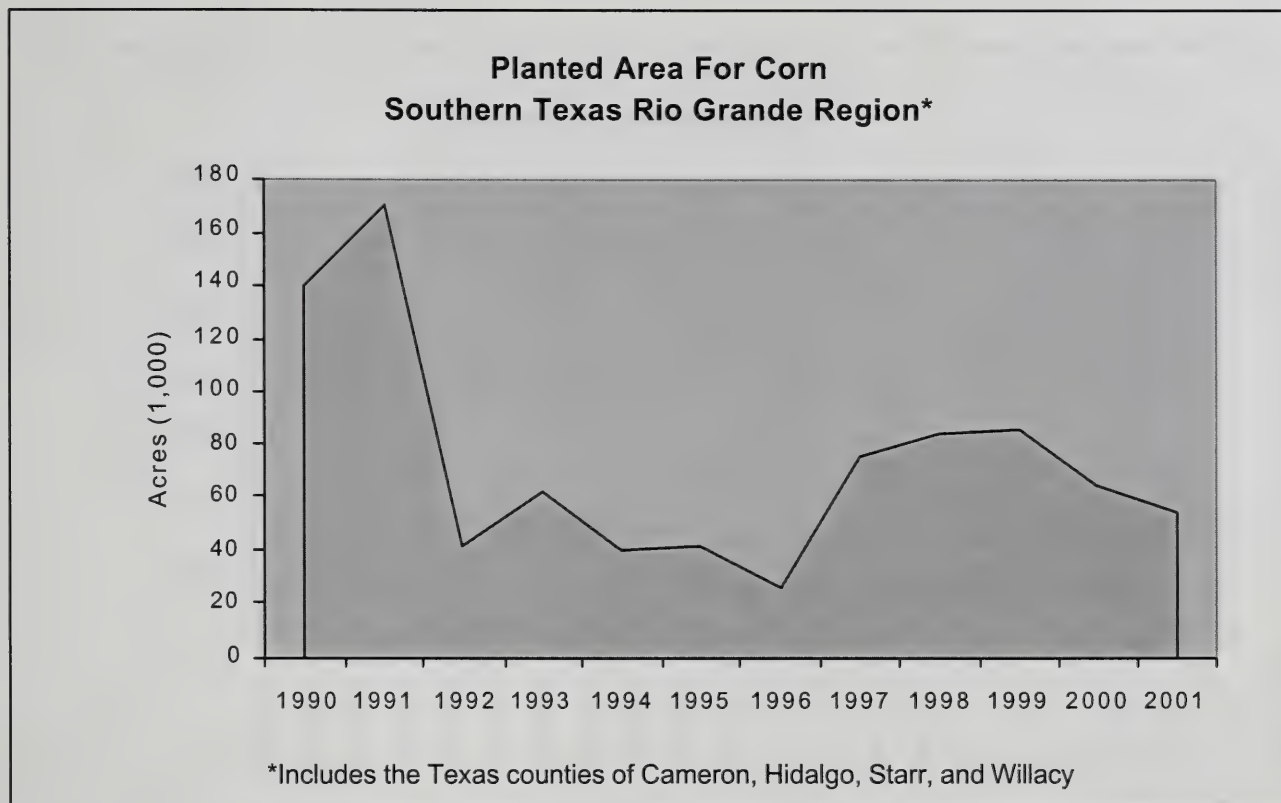


Figure 13

Source: Texas Agricultural Statistics Service (TASS)

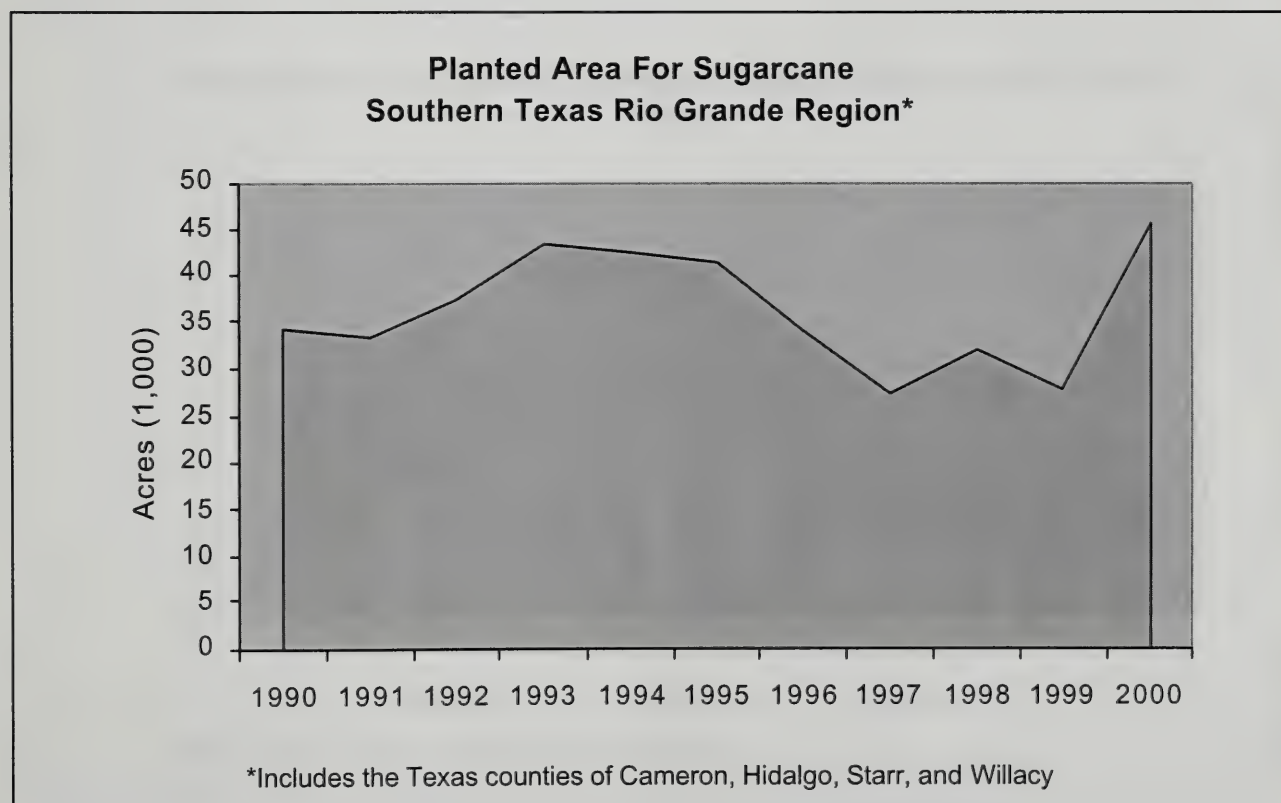


Figure 14

Source: Texas Agricultural Statistics Service (TASS)





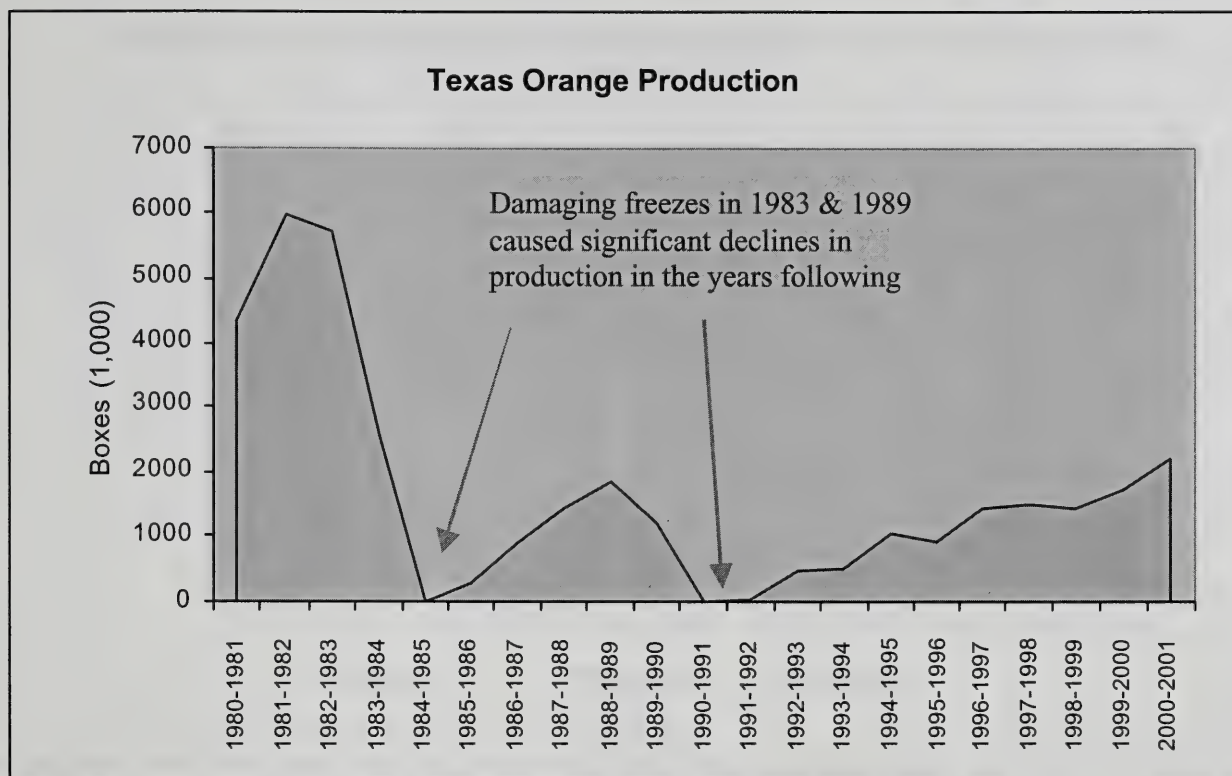


Figure 15

Source: Texas Agricultural Statistics Service (TASS)

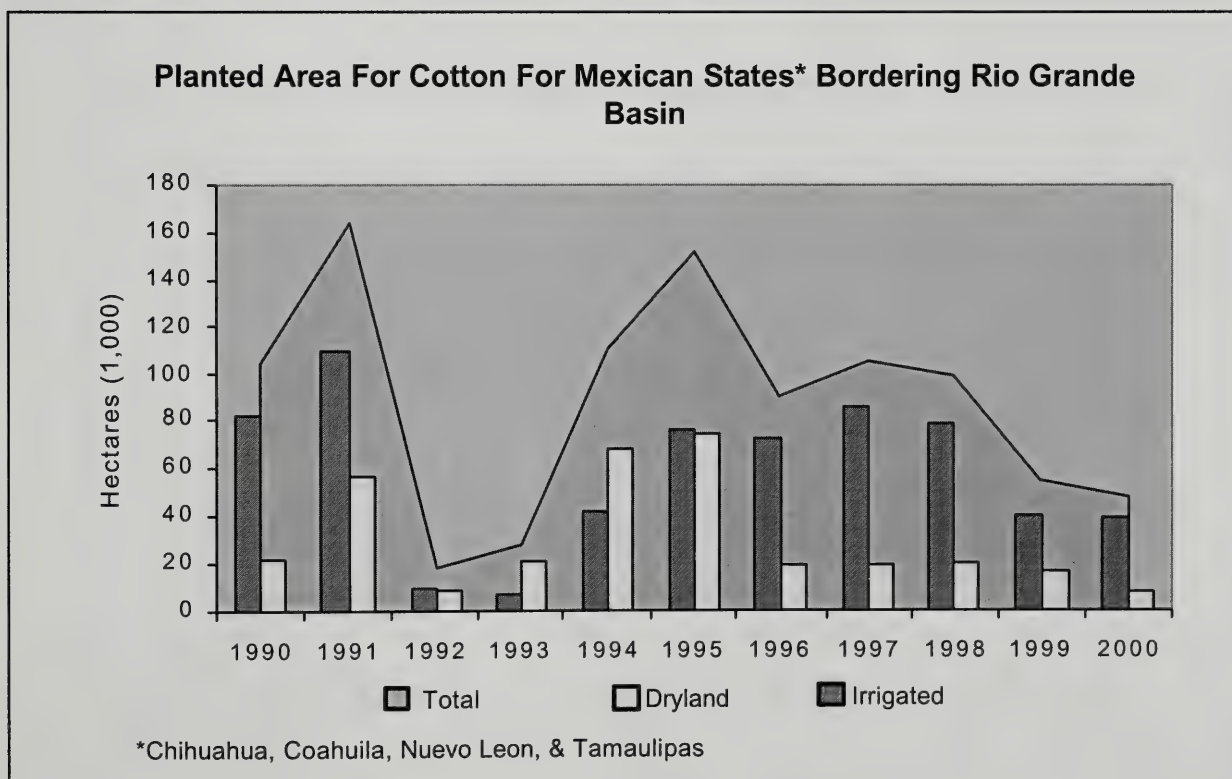


Figure 16

Source: Mexican Ministry of Agriculture, Livestock, Rural Development, Fishery, and Food (SAGARPA)



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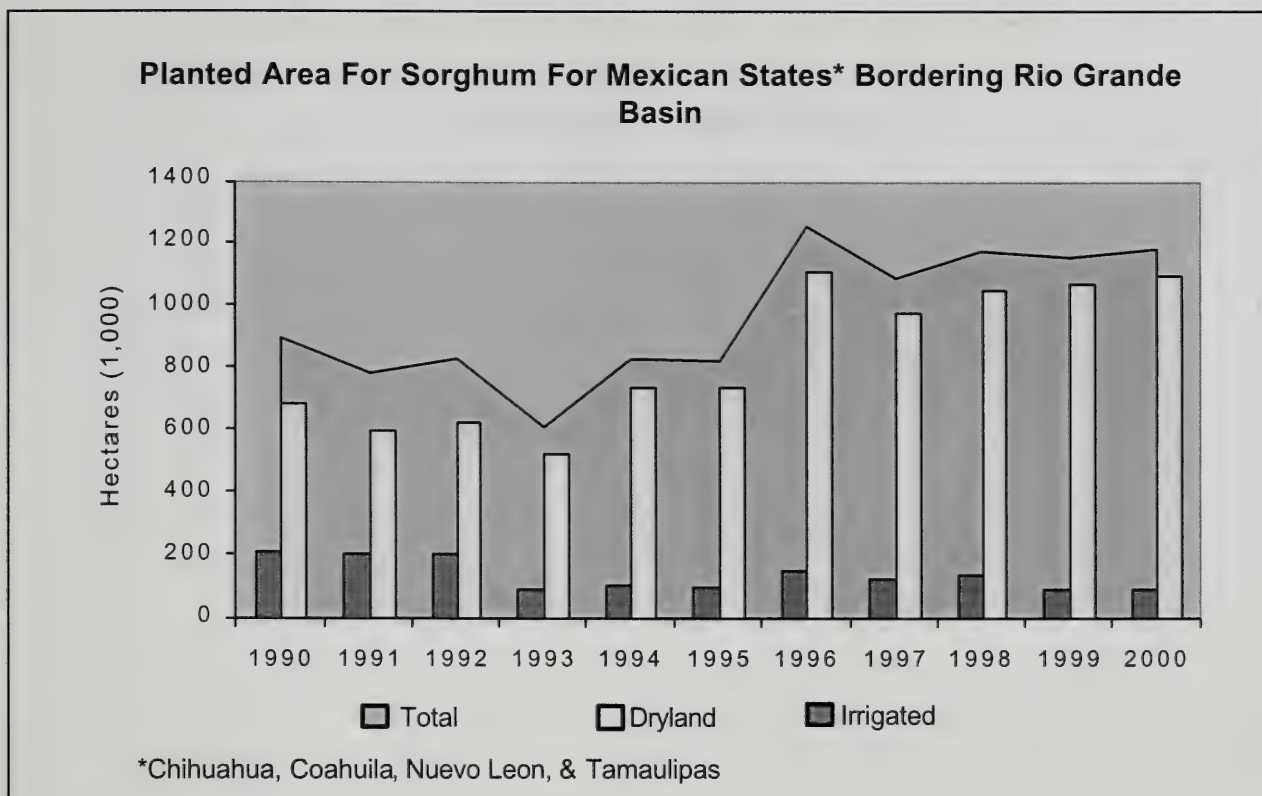


Figure 17

Source: Mexican Ministry of Agriculture, Livestock, Rural Development, Fishery, and Food (SAGARPA)

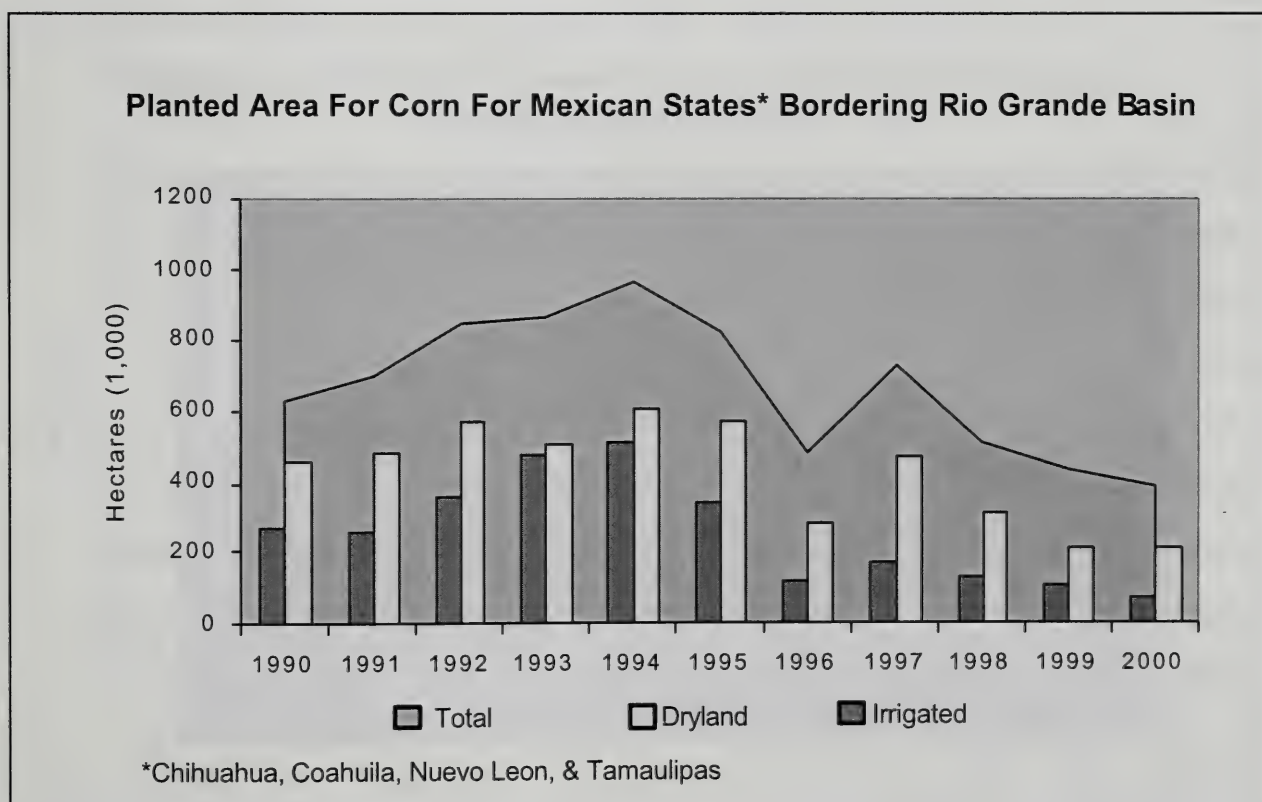


Figure 18

Source: Mexican Ministry of Agriculture, Livestock, Rural Development, Fishery, and Food (SAGARPA)



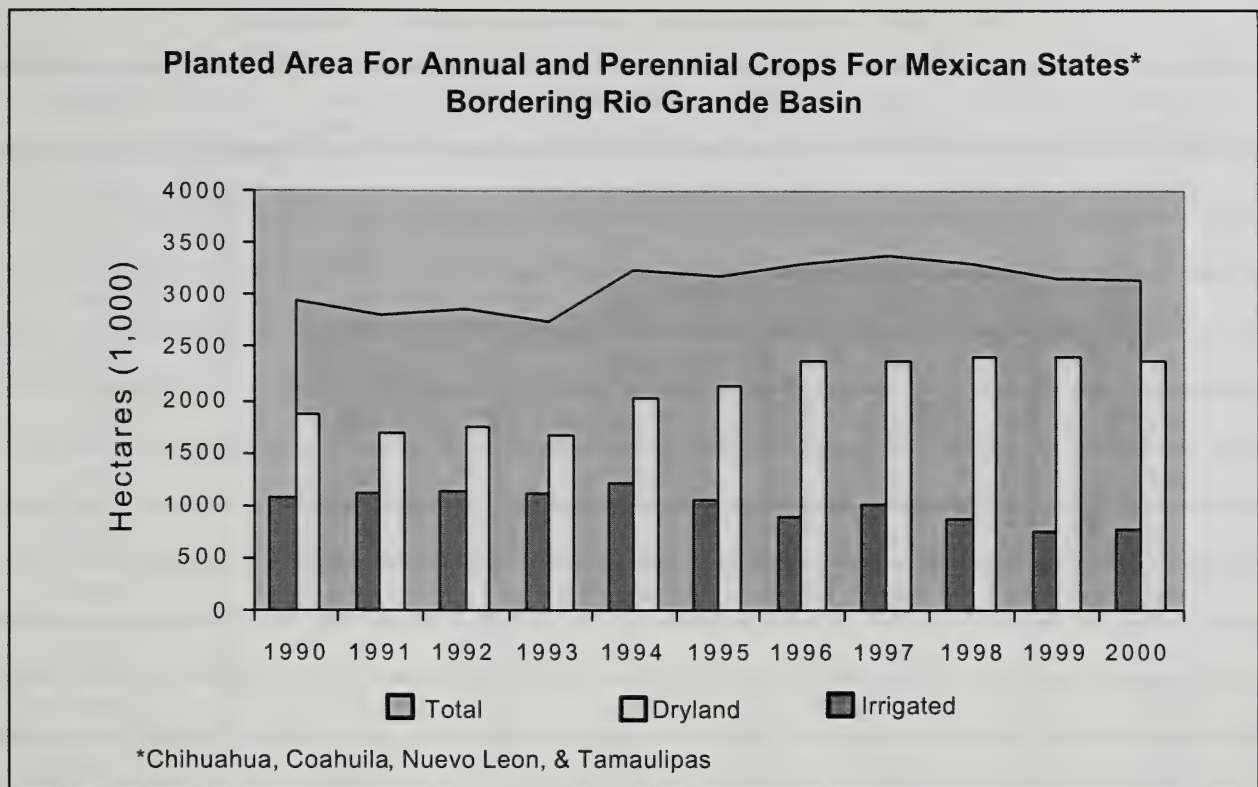


Figure 19

Source: Mexican Ministry of Agriculture, Livestock, Rural Development, Fishery, and Food (SAGARPA)

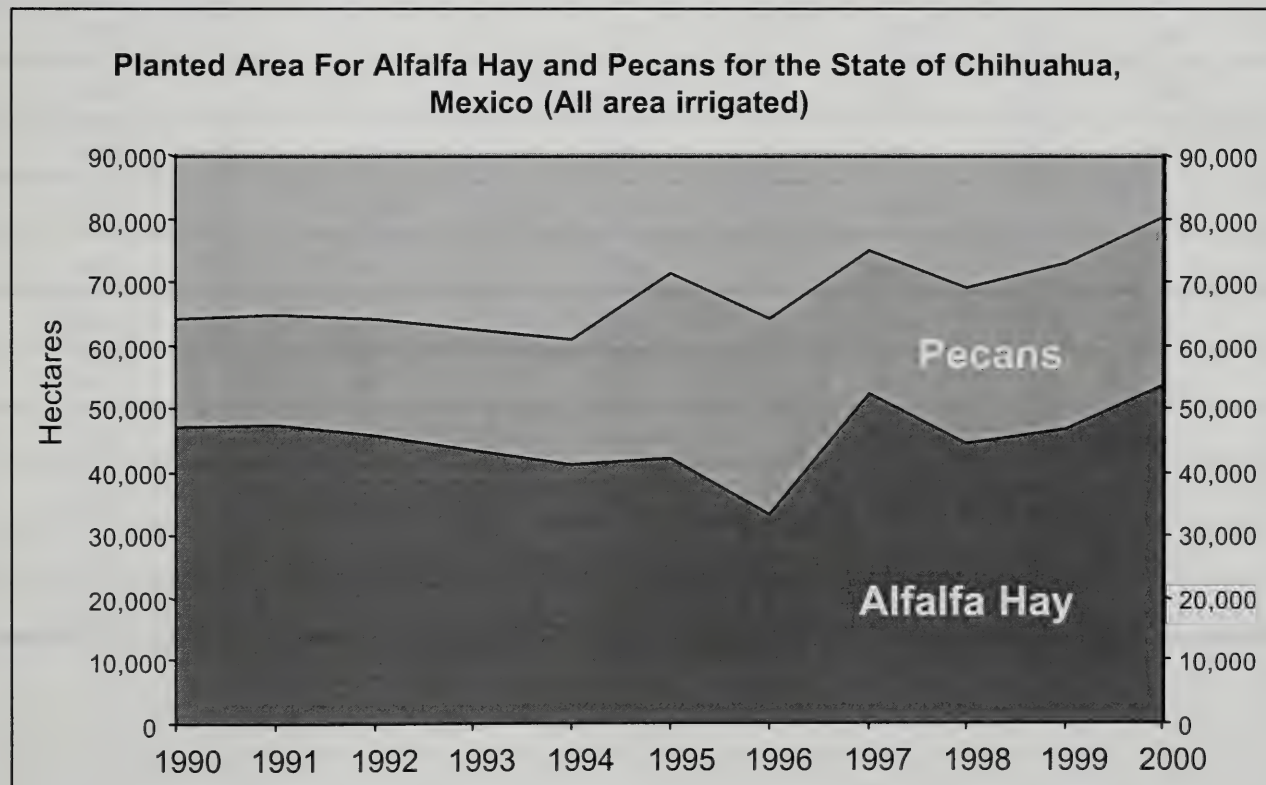


Figure 20

Source: Mexican Ministry of Agriculture, Livestock, Rural Development, Fishery, and Food (SAGARPA)





**Appendix Table 1 – Cotton: Southern Rio Grande Area**

Crop Year	Planted (1,000 Acres)	Harvested (1,000 Acres)	Yield (Pounds/Acre)	Production (1,000 Bales) <u>1/</u>
Dryland				
1990	229	207	378	163
1991	199	175	414	151
1992	175	149	454	141
1993	162	157	599	196
1994	146	139	559	162
1995	179	62	170	22
1996	99	84	451	79
1997	93	87	513	93
1998	130	109	370	84
1999	157	128	431	115
2000	163	135	622	175
Irrigated				
1990	120	118	683	168
1991	202	190	505	200
1992	120	103	624	134
1993	126	123	620	159
1994	140	137	603	172
1995	180	118	195	48
1996	81	76	543	86
1997	64	60	704	88
1998	90	89	674	125
1999	95	93	645	125
2000	82	80	630	105





**Appendix Table 1 – Cotton: Southern Rio Grande Area (continued)**

Crop Year	Planted (1,000 Acres)	Harvested (1,000 Acres)	Yield (Pounds/Acre)	Production (1,000 Bales) <u>1/</u>
Total				
1990	349	325	489	331
1991	401	365	462	351
1992	295	252	524	275
1993	288	280	609	355
1994	286	276	581	334
1995	359	180	187	70
1996	180	160	495	165
1997	157	147	591	181
1998	220	198	507	209
1999	252	221	521	240
2000	245	215	625	280

Source: Texas Agricultural Statistics Service (TASS).

1/ 480-lb. net weight bales.



**Appendix Table 2 – Grain Sorghum: Southern Rio Grande Area**

Crop Year	Planted (1,000 Acres)	Harvested (1,000 Acres)	Yield (Bu./Acre)	Production (1,000 Bu.)
Dryland				
1990	203	182	38.7	7,025
1991	208	165	48.5	8,009
1992	380	351	55.5	19,474
1993	338	334	58.7	19,619
1994	315	290	52.7	15,296
1995	291	241	27.8	6,711
1996	354	300	41.5	12,450
1997	230	214	53.1	11,356
1998	236	224	45.1	10,098
1999	282	280	49.4	13,837
2000	292	286	55.7	15,916
2001	292	263	34.6	9,089
Irrigated				
1990	62	56	88.2	4,975
1991	78	75	72.4	5,432
1992	84	81	70.9	5,744
1993	78	76	75.7	5,754
1994	110	110	77.8	8,554
1995	86	84	73.5	6,173
1996	136	130	77.3	10,055
1997	102	97	70.1	6,798
1998	91	87	69.7	6,064
1999	77	77	68.4	5,270
2000	103	100	69.1	6,877
2001	103	101	68.0	6,866

Source: Texas Agricultural Statistics Service (TASS).





**Appendix Table 2 – Grain Sorghum: Southern Rio Grande Area (continued)**

Crop Year	Planted (1,000 Acres)	Harvested (1,000 Acres)	Yield (Bu./Acre)	Production (1,000 Bu.)
Total				
1990	265	238	50.4	12,000
1991	286	240	56.0	13,441
1992	464	432	58.4	25,218
1993	416	410	61.9	25,373
1994	425	400	59.6	23,850
1995	377	325	39.6	12,884
1996	490	430	52.3	22,505
1997	332	311	58.4	18,154
1998	327	311	52.0	16,162
1999	359	357	53.5	19,107
2000	395	385	59.2	22,793
2001	395	364	43.8	15,955

Source: Texas Agricultural Statistics Service (TASS).





**Appendix Table 3 – Corn for Grain: Southern Rio Grande Area**

Crop Year	Planted (1,000 Acres)	Harvested (1,000 Acres)	Yield (Bu./Acre)	Production (1,000 Bu.)
1990	140	115	52	6,028
1991	170	130	84	10,965
1992	42	37	84	3,100
1993	63	55	88	4,815
1994	40	36	80	2,862
1995	42	38	56	2,109
1996	27	22	82	1,805
1997	75	59	74	4,333
1998	84	62	51	3,137
1999	86	67	56	3,725
2000	65	64	60	3,800
2001	54	47	58	2,678

Source: Texas Agricultural Statistics Service (TASS).

**Appendix Table 4 – Sugarcane: Southern Rio Grande Area**

Crop Year	Harvested (Acres)	Yield (Tons/Acre)	Production (1,000 Tons)
1990	34,400	26.5	913
1991	33,200	32.4	1,080
1992	37,700	34.2	1,290
1993	43,500	32.5	1,412
1994	42,400	31.5	1,334
1995	41,200	32.4	1,336
1996	34,600	28.7	992
1997	27,300	30.3	827
1998	32,000	32.9	1,053
1999	28,000	34.1	955
2000	45,500	38.8	1,765

Source: Texas Agricultural Statistics Service (TASS).

**Appendix Table 5 – All Vegetables: Southern Rio Grande Area**



Item	Harvested, all ( <i>Acres</i> )			Harvested, irrigated ( <i>Acres</i> )	
	1992	1997	1999	1992	1997
Crop Year	1992	1997	1999	1992	1997
All vegetables	68,069	42,878	NA	62,559	35,007
Onions <u>1/</u>	9,479	7,642	9,000	9,475	6,735
Watermelon <u>2/</u>	11,246	7,754	9,200	6,327	5,944
Cabbage <u>3/</u>	5,678	4,124	3,800	5,658	3,608
Cantaloupe <u>4/</u>	8,831	NA	NA	8,577	NA

Notes: 1992 and 1997 are Census data. Some counties did not report in 1997 due to confidentiality reasons, but the area was small, probably less than 100 acres. 1999 data for harvested area are TASS estimates.

Source: Texas Agricultural Statistics Service (TASS).

1/ Includes Cameron, Hidalgo, Starr.

2/ Irrigated area for 1992 excludes Starr.

3/ Includes Cameron and Hidalgo.

4/ Includes Hidalgo and Starr.

**Appendix Table 6 – Citrus Production: Southern Rio Grande Area (1,000 Boxes)**

Crop Year	Grapefruit	Oranges	Crop Year	Grapefruit	Oranges
1980-81	6,700	4,330	1991-92	65	30
1981-82	13,900	5,940	1992-93	1,875	510
1982-83	11,200	5,680	1993-94	3,000	550
1983-84	3,200	2,510	1994-95	4,650	1,055
1984-85	0	0	1995-96	4,550	940
1985-86	220	310	1996-97	5,300	1,420
1986-87	1,925	875	1997-98	4,800	1,525
1987-88	3,800	1,430	1998-99	6,100	1,430
1988-89	4,800	1,850	1999-00	5,930	1,740
1989-90	2,000	1,205	2000-01	7,200	2,235
1990-91	0	0			

Source: Texas Agricultural Statistics Service (TASS).





**Appendix Table 7 – U.S. Imports of Melons and Onions From Mexico**

Product	Melons		Onions	
<i>Calendar year/units</i>	<i>\$ mil.</i>	<i>1,000 mt</i>	<i>\$ mil.</i>	<i>1,000 mt</i>
1992	68.6	229	94.4	154
1993	51.1	200	91.1	194
1994	67.6	218	116.5	178
1995	89.9	289	117.9	184
1996	114.3	402	130.0	228
1997	121.0	439	111.4	218
1998	146.0	445	124.5	211
1999	174.5	507	106.4	183
2000	128.2	407	113.0	149
2001	137.6	376	123.1	176

Source: Bureau of the Census, as report by USDA.





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